Site Diagnosis, Tree Species Selection, and Slashburning Guidelines for the Vancouver Forest Region, British Columbia.

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Site Diagnosis, Tree Species Selection, and Slashburning Guidelines for the Vancouver Forest Region

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1. INTRODUCTION

For the past six years, forestry personnel in the Vancouver Forest Region have been using the second approximation of the "Guide for the Tree Species Selection and Prescribed Burning in the Vancouver Forest District" (Klinka 1977) for making planting and prescribed burning prescriptions. Progress in ecosystem studies, testing of recommended tree species, and the intent to provide more flexibility resulted in this third approximation of the guide.

The intent of this guide is to help in assessing site quality, selecting the most appropriate tree species combination for timber production, and identifying the sensitivity class of a forest site to fire. Thus, the guide should be used as the basis for making site-specific tree species and site preparation prescriptions. The site units used for tree species selection can also be used in making decisions on planting stock, planting time, stocking standards, regeneration methods, fertilization, and other forestry practices, even if such information has not been included in the guide. The guide is available in two formats, the abridged field guide which contains only information considered essential for field application, and this expanded version containing detailed background information. The three major sections of the guide are: site diagnosis, tree species selection guidelines, and slashburning guidelines.

Site diagnosis deals with the identification of climatope, hygrotope, and trophotope - the major elements used to define site quality. They are derived from the environmental and indicator plant analyses. Sites of similar quality are grouped into "site units" and displayed on edatopic grids. The site units are used to convey tree species recommendations together with estimates of potential productivity. To clarify how the tree species/site combinations were derived and to facilitate their amendments with regard to local conditions, the underlying concepts and principles of tree species selection are included.

A new approach to making burning prescriptions has been adopted. It is based on a fire sensitivity classification of forest sites, which is determined using similar characteristics required for site diagnosis. Following an assessment of site sensitivity to fire, the reasons for burning, and the impact of fire on selected tree species, the decision whether or not to burn can be made. Site-specific guidelines for burning prescriptions, however, are contained in a separate manual[1].

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[1] Manual for prescribed burning in the Vancouver Forest Region (in preparation). Ministry of Forests, Protection Section, Vancouver, B.C., MacMillan Bloedel Ltd., Forestry Division, Nanaimo, B.C.

2. SITE DIAGNOSIS

2.1 Synopsis

Site diagnosis is a field-based procedure for determining site quality and thereby classifying different forest sites. It is based on an evaluation of selected soil properties and indicator plant species which are integrated to identify the three site elements: climatope, hygrotope, and trophotope. By using these elements as differentiating characteristics, sites can be classified. Determining site quality is a prerequisite to site-specific tree species selection, site preparation, and other decision-making processes in forest management operations.

2.2 The Concept of Site Diagnosis

A biotic community and its environment compose a forest ecosystem. The biotic (forest) community encompasses the living features of the ecosystem, with vegetation as the most discernible component. This component is relatively unstable - it changes through succession and can be significantly modified by natural disturbances and/or management practices. The environment encompasses climatic, physiographic, and edaphic (soil) features of the ecosystem. In contrast to the forest community, it is essentially stable within the time frame associated with forest managment.

We define a forest site as every part of the forest environment that is relatively uniform in climate, physiography, and soils, and has the same biotic potential, usually expressed by a specific pattern of indicator plant species. Within a given regional climate, sites are recognized on the basis of significant differences in topography (slope position, gradient and aspect), soil parent materials, and/or morphological properties of the soil (e.g., the kind and arrangement of organic and mineral soil horizons, their colour, texture, structure, consistency, thickness, and coarse fragment content).

Numerous workers have classified forest ecosystems and studied vegetation-environment relationships. The recognized units have been commonly differentiated, characterized and named according to diagnostic vegetation. From a forestry perspective, however, the intent has been to identify ecologically meaningful units differing in site properties, but which could be referred to floristically for ease of identification.

A review of classification systems successfully applied in intensive forestry indicates that classification units include ecosystems grouped according to site properties, irrespective of vegetation successional stage. Thus, the basic unit represents a group of sites that have the capacity or potential to produce similar vegetation (Arbeitskreis Standortskartierung 1978, Cajander 1949, Frey 1980, Genssler 1982, Hills 1952, Pogrebnyak 1930). Other workers have developed classification systems that use vegetation as a differentiating characteristic but which also provide for the organization of recognized units according to causal environmental factors (e.g., Alexandrova 1980, Bakuzis 1969, Daubenmire 1968, Ellenberg 1982, Etter 1954, Krajina 1969, Mayer 1977, Mueller-Dombois 1964, Randuska 1982). Both approaches have been found to be more meaningful for application in intensively managed forests than strictly vegetation-based systems.

Second growth forest management will maintain most forest stands in seral stages which will be markedly different in some properties from the original stands as well as from those undergoing natural succession. As a result, forest ecosystems found on similar sites may express considerable variability in vegetation composition (particularly tree species), humus form, surface soil layer, and biogeochemical cycling.

There is a practical need to reduce the dependence on vegetation features and to minimize the taxonomic complexity when classifying second growth forests. The complexity of seral vegetation-environment relationships has caused problems for vegetation-based classifications. For example, a forest community that is climax for one site may occur, in more or less similar form, as seral for another site(s) or a particular early seral community may occur on a number of different sites. The identification of seral ecosystems with significantly altered, poorly developed or even lacking vegetation is often problematic and may not be relevant for managed, second growth forests. In general, vegetation features are influenced by stand type and density and therefore, when considered alone, may not reflect relevant environmental differences affecting tree growth (Kreutzer 1978).

It is the site component of an ecosystem that allies floristically different seral communities with the climax stage, even in cases where vegetation is temporarily lacking. This is based on the premise that under similar environmental conditions, secondary succession will yield similar climax ecosystems. Therefore, site classification or the site approach to ecosystem classification requires the study of environmental properties of ecosystems, a feature inherent in biogeoclimatic ecosystem classification (Krajina 1969). It is possible to use those environmental properties which were found to differentiate mature, near-climax, and climax ecosystems and those plants which were found to indicate certain ecological conditions to classify forest sites or ecosystems independent of their successional status. The resulting classification units have similar biotic potential (quality), and can be grouped or subdivided according to the desired degree of generalization.

The site-specific approach to forest management requires (a) recognition of different forest sites and (b) identification of their qualities. Site diagnosis, as presented in this guide, is defined as a procedure to determine quality of forest sites using their environmental properties with the aid of vegetation. It has been devised specifically for practical application in the field. Environmental properties, such as slope position, soil texture, and humus form, are examined together with indicator plant species for each site. When combined with climatic properties, expressed by biogeoclimatic units, these data can be used to assess site quality. Kreutzer (1980) considered this an environmental method of site classification where sites are characterized and classified using their "physical condition such as properties of the soil, topography and climate. Vegetation is also frequently used as a supplementary indicator . . . ."

While based on biogeoclimatic ecosystem classification, site diagnosis does not require identification of formally recognized taxonomic units except biogeoclimatic subzones or variants. Sites are classified (differentiated and named) according to the three elements - climatope, hygrotope, and trophotope. The user is required to examine and integrate a set of soil and floristic properties. This leads to a better understanding of ecosystem complexities, i.e. how these properties interact and reflect the quality of different forest sites, and results in more precise diagnoses and decision-making. The site diagnosis methods presented in this guide are aimed towards efficient field application using available techniques. Computer-assisted methods of site diagnosis are currently in the developmental stages.

2.3 Elements of Site Diagnosis

The site component has been subdivided into climatope (climate) and edatope (soil). Edatope has been subdivided by Pogrebnyak (1930) into hygrotope (soil moisture regime) and trophotope (soil nutrient regime), and the combination of climatope and edatope is referred to as ecotope (Sukachev and Dylis 1968). There is general agreement among ecologists that climatope, hygrotope, and trophotope have a determining influence on the composition, structure, and vigour of forest communities. Among all factors, they affect the nature and distribution of ecosystems in the landscape most strongly (Bakuzis 1969, Ellenberg 1982, Fowells 1965, Hills 1952, Jahn 1982, Krajina 1969, Malcolm 1981, Mayer 1977, Pogrebnyak 1930, Pritchett 1979, Tisdale and Nelson 1975, Whittaker 1980). Thus, these three elements are used as differentiating characteristics to classify forest sites.

Each unique combination of climatope, hygrotope, and trophotope, i.e. each ecotope, represents a very specific group of sites. For example, in the CWHa2 Biogeoclimatic Variant, slightly dry, nutrient-very poor (CWHa2:

3/A) sites and fresh, nutrient-poor (CWHa2:4/B) sites represent two different ecotopes (cf. Sections 2.3.3 and 2.3.4 for explanation of codes). However, individual ecotopes are generally too detailed to be of major significance for vegetation response and management purposes. Thus for practical application, we benefit from further generalization of ecotopes.

For management purposes, interpretative groupings of ecotopes are required. Such groupings are termed site units. In this guide, site units have been generalized at the level suitable for making tree species and silvicultural regime decisions (cf. Section 3.3). In the above example, these two ecotopes have been grouped to form one interpretive site unit which includes slightly dry to fresh, nutrient-very poor to medium ecotopes.

2.3.1 Climatope

Climate is the most influential ecosystem-forming factor (Jenny 1980, Major 1963, Sukachev and Dylis 1968). Thus, it is useful to recognize groups of ecosystems which are affected by the same or similar climate. However, this is usually difficult; climatic data are often sparse or for some areas entirely lacking, and climatic analysis alone cannot provide a reliable functional link between climate and ecosystem. To overcome this difficulty, the zonal concept, applied by many workers to classification of vegetation, soils, or landscapes (Glazovskaya 1963, Major 1951, Perelman 1966, Polynov 1951, Sukachev and Dylis 1968, Walter 1973) has been adopted by Krajina (1969, 1972) for biogeoclimatic ecosystem classification.

The zonal ecosystem can be described as follows. Additions of materials and energy to a zonal ecosystem occur primarily from the atmosphere, with precipitation as the predominant input of water. They neither receive nor shed an excess of water or nutrients. These functional attributes result in the relatively independent nature of biogeochemical cycling, energy exchange, and development of zonal ecosystems.

Zonal ecosystems generally occur on gently sloping terrain, thereby diminishing the effect of slope and aspect. The soils of zonal ecosystems have intermediate moisture and nutrient regimes in relation to neighbouring non-zonal ecosystems, which are influenced more strongly by local physiography (e.g., slope position, gradient, and aspect) and/or the physical and chemical properties of parent materials. These neighbouring ecosystems do not reflect the regional climate so clearly, being drier, wetter, richer, or poorer than zonal ecosystems.

Zonal ecosystems are important benchmarks which are used to create climatically uniform groups of ecosystems because they express the influence of regional climate most strongly. They are products of their respective regional climates, which dominate their development in time and space. Zonal ecosystems are used to recognize biogeoclimatic units and their distribution in the landscape and used to delineate areas with similar regional climates.

2.3.2 Biogeoclimatic Units of the Vancouver Forest Region

The categories of biogeoclimatic zone, subzone, and variant are used by the Ministry of Forests in its biogeoclimatic ecosystem classification program to identify areas with similar climatic potential in the sense that their climax zonal ecosystems have several features in common. Zones are the most general category; their zonal ecosystems are usually differentiated from those of other zones primarily on the basis of climax tree species after which they are named (the Alpine Tundra Zone is the only exception in that it lacks a tree stratum). However, other plant species often are also differentiating. Zones have a characteristic pattern of azonal ecosystems and their zonal ecosystems undergo similar pedogenic and biochemical processes. Krajina (1973) has mapped the distribution of biogeoclimatic zones in British Columbia. Presently, the Ministry of Forests is preparing an updated biogeoclimatic zone map.

Subzones are a more specific category than zones. Their zonal ecosystems have several differentiating plant species with the exception that in any zone one subzone may be characterized by an absence of differentiating plant species. Subzones have a more specific pattern of azonal ecosystems than do zones and their zonal ecosystems undergo more specific pedogenic and biogeochemical processes. The ecosystem association is the category in the classification system which is used to generalize the zonal ecosystems of a subzone.

Variants are the most specific category in biogeoclimatic classification. Differentiating plant species may be present in the zonal ecosystems of certain variants, but often the differences are less obvious, being manifest only in the abundance and vigor of plant species and in the pattern of azonal ecosystems across the landscape. Variants are usually identified when a subzone includes considerable latitudinal, orographic or elevational variation. Details regarding principals of biogeoclimatic classification as employed by the Ministry of Forests are discussed by Klinka _et al_. (1985)[1].

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[1] Klinka, K., J. Pojar, and D.L. Meidinger. 1985. Taxonomic classification of ecosystems in British Columbia. Province of British Columbia, Ministry of Forests, Victoria, B.C. (in manuscript).

The biogeoclimatic units presented below are based on tabular analysis (Mueller-Dombois and Ellenberg 1974) of over 200 zonal ecosystem plots from the continuously forested portion of the Mountain Hemlock Zone, the Coastal Western Hemlock Zone and the Interior Douglas-fir Zone. This analysis was not possible for the Alpine Tundra Zone because it is not forested and has not been sampled; the Engelmann Spruce - Subalpine Fir Zone because it has limited occurrence in the region; and the Coastal Douglas-fir Zone because anthropogenic disturbance has resulted in a dearth of climax zonal ecosystems. For the latter units, classification was based on available literature, unpublished information, and the observations of the authors.

Within the Vancouver Forest Region there are six zones, 14 subzones (plus one undifferentiated unit), and 15 variants (Table 1). The number of biogeoclimatic units and their names and numbers have changed somewhat from earlier maps and reports, therefore a list of synonyms for the new units is also presented in Table 1.

The symbols used for tree species throughout the guide are listed in Table 2. Latin name abbreviations would be more consistent with the latin names of non-tree species; however, these would not be so readily recognized by operational personnel who are familiar with the Ministry of Forests Inventory Branch abbreviations.

The maritime-continental gradient from the coast to the interior has been subdivided into hypermaritime, maritime, submaritime, subcontinental, and continental areas, some of which are subdivided into central and southern, or windward and leeward (Figure 1). The division was based on the distribution of biogeoclimatic subzones and variants and the names of these units include the respective maritime-continental element, if one is applicable.

In Figure 2 climatic data are presented from a representative climatic station which had intermediate precipitation and temperature regime relative to all available stations for a biogeoclimatic subzone or variant (for several units only one station was available). The presentation format is based on Walter's (1973) approach. The information presented includes: annual precipitation and temperature regime; the absolute maximum, mean maximum, mean minimum and absolute minimum temperatures; the month when frost may occur (i.e., when the absolute minimum temperature over the period of record falls below 0°C); the month when frost is likely (i.e., when the mean minimum temperature falls below 0°C); and the station location, elevation, mean annual temperature, mean total annual precipitation, and the years of record. In addition to climatic diagrams, snow survey data are presented for stations representing the subalpine biogeoclimatic units in Table 3.

The following descriptions of biogeoclimatic subzones and variants include differentiating characteristics, additional characteristics, a description of major climatic parameters, information on the distribution of the unit, and if applicable, references. Differentiating characteristics for subzones include firstly, the zonal ecosystem association which is named after major plant species in the unit, and secondly a list of differentiating plant species. For variants only the differentiating plant species are listed since the zonal ecosystem is the same as the one for the respective subzone. Additional characteristics include any major species not listed in the name of the zonal ecosystem association, other salient floristic features, the occurrence of humus forms on zonal ecosystems classified according to Klinka et al. (1981), soils classified according to CSSC (1978), and finally the grid identifying the pattern of sites within the unit. Climatic information is presented for purposes of characterization of the units. Information regarding the distribution of the unit includes elevational limits. The reader is cautioned that these are generalized for the unit and actual limits can vary considerably as one progresses from its western to eastern or northern to southern limits or encounters southern and northern exposures, cold air drainage basins and narrow valleys.

The organization of the biogeoclimatic units according to orographic element (alpine to submontane), degree of maritime versus continental influence (hypermaritime to continental) and where appropriate, according to precipitation regime is shown in Figure 3. This organization also shows how the units are related to one another.

The first step in identification of a biogeoclimatic unit is to consult the biogeoclimatic map. Next, several climax or near-climax zonal ecosystems should be examined in the vicinity of the area of interest and a list of plant species prepared, and soil and humus form data collected. These data should then be compared with the information in this section of the guide. Confirmation of zonal ecosystem associations and differentiating species where these are present is preferable, however, matching of major species is also suitable. In the event that climax zonal ecosystems cannot be found, the pattern of sites as outlined on the grids for the biogeoclimatic units can be compared with those present in the area. Although the latter method of identification is less desirable than the survey of climax zonal ecosystems, it is sometimes necessary.

TABLE 1. Biogeoclimatic units in the Vancouver Forest Region

				Equivalent Units	
Zone	**Subzone**	**Variant[1]**	**Grid[2]**	**2nd Approximation[3]**	**Other[4]**
ALPINE TUNDRA (AT)	**Coastal AT (ATa)**		—	—	**ATa, ATb**
MOUNTAIN HEMLOCK (MH)	**Parkland MH (MHp)**		—	—	**MHap, MHbp**
	Maritime Forested MH (MHa)		**1**	**MHxa**	**MHa1, MHa2, MHa3**
	Submaritime Forested MH (MHb)		**2**	**MHya**	**MHb**
ENGELMANN SPRUCE - SUBALPINE FIR (ESSF)	**Parkland ESSF (ESSFp)**		—	—	—
	Subcontinental Forested ESSF (ESSFf)		**3**	**ESSFa**	**ESSFf**
	Dry Southern Forested ESSF (ESSFe)		—	—	—
INTERIOR DOUGLAS-FIR (IDF)	**Subcontinental IDF (IDFe)**	**Southern IDFe (IDFe1)**	**4**	**IDFb**	**IDFe**
		Central IDFe (IDFe2)	**5**	—	**CWHh2**
	[Undifferentiated IDF (IDFu)][5]		**4**	—	**IDFb, IDFc, IDFd**
COASTAL DOUGLAS-FIR (CDF)	**Drier Maritime CDF (CDFa)**		**6**	**CDFa**	**CDFa1**
	Wetter Maritime CDF (CDFb)		**6**	**CDFb**	**CDFb1, CDFb2**
COASTAL WESTERN HEMLOCK (CWH)	**Drier Maritime CWH (CWHa)**	**Vancouver Island CWHa (CWHa1)**	**7**	**CWHxa**	**CWHa1, CWHa2**
		Pacific Ranges CWHa CWHa2)	**8**	**CWHxa**	**CWHa3**
	Wetter CWH (CWHb)	**Windward Submontane Maritime CWHb (CWHb1)**	**9**	**CWHxb-s**	**CWHb2, CWHb6 (CWHe) (CWHi1)**
		Windward Montane Maritime CWHb (CWHb2)	**10**	**CWHxb-m**	**CWHb3, CWHb7, (CWHe), (CWHi2)**
		Leeward Submontane Maritime CWHb (CWHb3)	**11**	**CWHxb-s**	**CWHb4**
		Leeward Montane Maritime CWHb (CWHb4)	**12**	**CWHxb-m**	**CWHb5**
		Southern Submaritime CWHb (CWHb5)	**13**	**CWHyb**	**CWHd**
		Central Submaritime Lower CWHb (CWHb6)	**14**	—	**CWHh3**
		Central Submaritime Upper CWHb (CWHb7)	**15**	—	**CWHi3**
	Drier Submaritime CWH (CWHc)	**Southern CWHc (CWHc1)**	**16**	**CWHya**	**CWHc**
		Central CWHc (CWHc2)	**17**	—	**CWHb1**
	Hypermaritime CWH (CWHd)	**Southern CWHd (CWHd1)**	**18**	—	**CWHb1 (CWHe), (CWHi1)**
		Central CWHd (CWHd2)		—	**CCPH**

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[1] In several cases variants have not been identified because of insufficient data.

[2] Grids for AT, MHp, and ESSFp are not provided since these areas will not be logged. No grid is supplied for the ESSFe since it occurs only in Manning Park where forestry operations do not occur; if necessary Grid 3 could be applied.

[3] "Second Approximation" = Klinka (1977).

[4] Other includes Klinka *et al.* (1979, 1980), Inselberg *et al.* (1982) and Courtin *et al.* (1981), and several unpublished Ministry of Forests internal reports. Parenthesis around symbols indicate that the unit has been divided.

[5] The IDF has not been fully differentiated into subzones because of insufficient data.

TABLE 2. Symbols, common, and latin names of tree species

Symbol	Common name	Latin name
Ac	black cottonwood	*Populus trichocarpa* Torr. & Gray *ex* Hook.
Ba	amabilis fir	*Abies amabilis* (Dougl. *ex* Loud.) Forbes
Bg	grand fir	*Abies grandis* (Dougl. *ex* D. Don) Lindl.
Bl	subalpine fir	*Abies lasiocarpa* (Hook.) Nutt.
Bp	noble fir	*Abies procera* Rehd.
Cw	western redcedar	*Thuja plicata* Donn *ex* D. Don in Lamb.
Dr	red alder	*Alnus rubra* Bong.
Fd	Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
Hm	mountain hemlock	*Tsuga mertensiana* (Bong.) Carr.
Hw	western hemlock	*Tsuga heterophylla* (Raf.) Sarg.
La	subalpine larch	*Larix lyallii* Parl.
Lw	western larch	*Larix occidentalis* Nutt.
Pa	whitebark pine	*Pinus albicaulis* Engelm.
Pl	lodgepole pine	*Pinus contorta* Dougl. *ex* Loud.
Pw	western white pine	*Pinus monticola* Dougl. *ex* D. Don in Lamb.
Py	yellow pine	*Pinus ponderosa* Dougl. *ex* P. & C. Lawson
Qg	Garry oak	*Quercus garryana* Dougl. *ex* Hook.
Se	Engelmann spruce	*Picea engelmannii* Parry *ex* Engelm.
Ss	Sitka spruce	*Picea sitchensis* (Bong.) Carr.
Sw	white spruce	*Picea glauca* (Moench) Voss
Yc	yellow-cedar	*Chamaecyparis nootkatensis* (D. Don) Spach

TABLE 3. Snow survey measurements (Anon. 1980) for subalpine biogeoclimatic units. Subzone abbreviations are as in Table 1

Biogeoclimatic unit, station	Elevation	Mean maximum	Mean 1 June	Maximum 15 June
	---- m ----	----------	cm	----------
MHp, Sno-Bird Lk, S. Vancouver Island	1400	338 (14)[1]	234 (13)	356
MHa, Mt. Seymour	1070	362 (21)	234 (20)	401
MHb, Whistler Mtn.	1450	204 (11)	97 (11)	175
ESSFp, Tenquille Lk.	1680	302 (28)	198 (27)	267
ESSFf, Lightning Lk.	1220	117 (34)	94 (1)	---
ESSFe, Bralorne	1450	183 (18)	24 (18)	---

[1] Years of record.

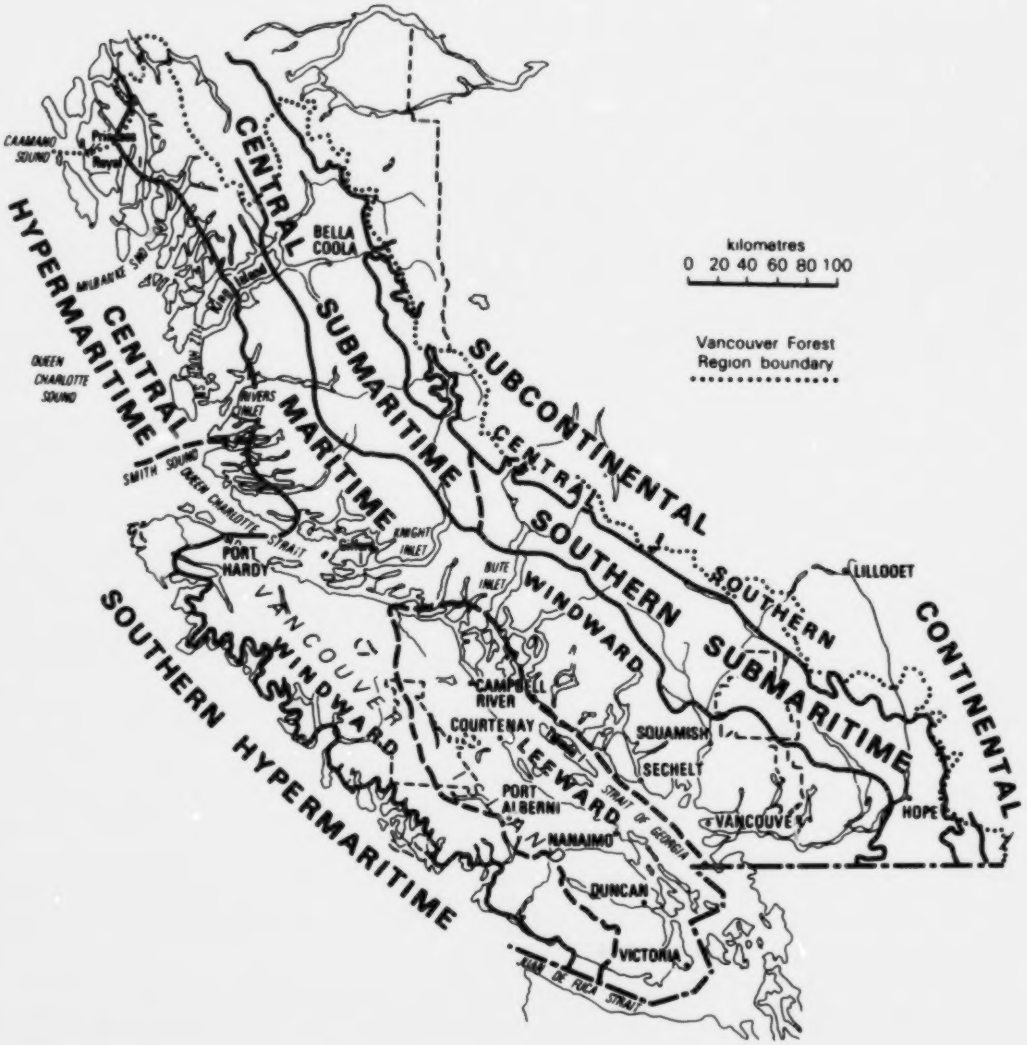
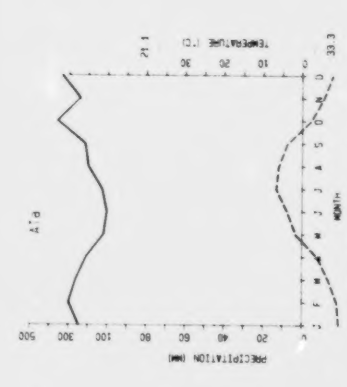
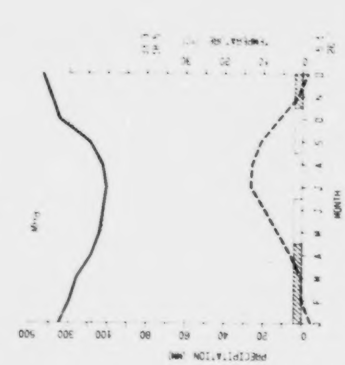


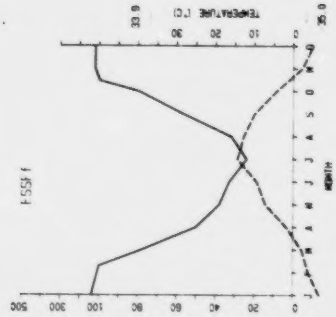
FIGURE 1. Map showing the distribution of hypermaritime, maritime, submaritime, and subcontinental areas as applied in naming biogeoclimatic subzones and variants.



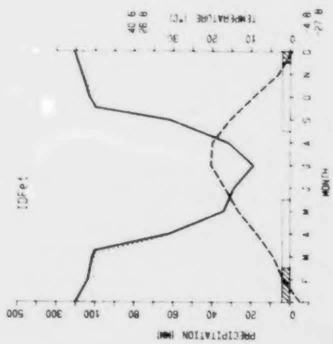
KEMANO-KILDALA PASS 1609 M 1.7 C 2743 MM
5-6 YRS RECORD END 1959



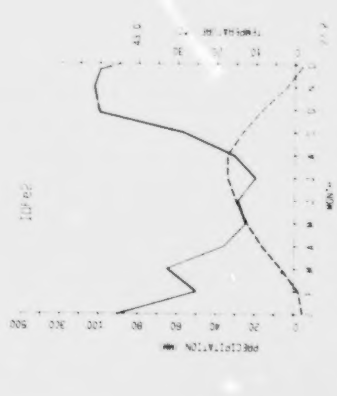
HOLYBURN RIDGE 951 M [illegible] C [illegible] MM
19-26 YRS RECORD



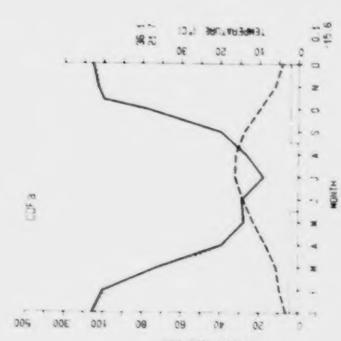
MANNING PK LODGE 1173 M 3.3 C 895 MM
8 YRS RECORD END 1961



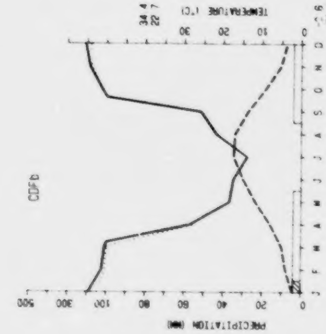
HELLS GATE 122 M 9.2 C 1199 MM
26-30 YRS RECORD



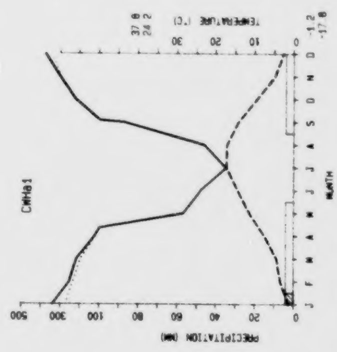
STAVE LODGE 140 M [illegible] C [illegible] MM
13-14 YRS RECORD END 1947



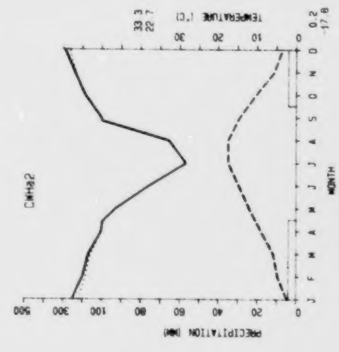
VICTORIA INT'L A 19 M 9.5 C 873 MM
40-41 YRS OF RECORD



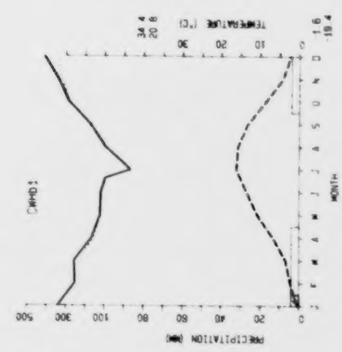
COMOX A 24 M 9.4 C 1215 MM
36-37 YRS OF RECORD



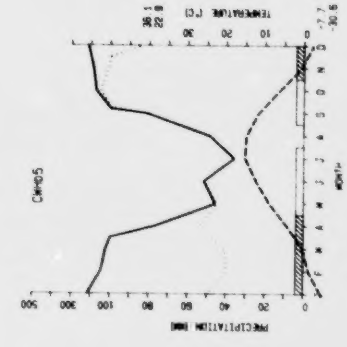
COWICHAN FORESTRY 177 M 9.1 C 2123 MM
29-32 YRS RECORD



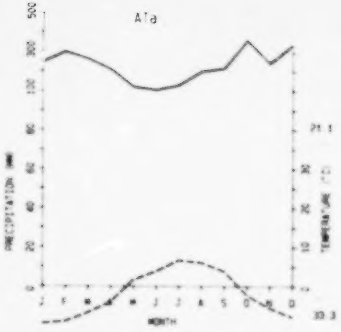
N VANCOUVER CLOVERLY 79 M 10.0 C 1880 MM
10-13 YRS RECORD



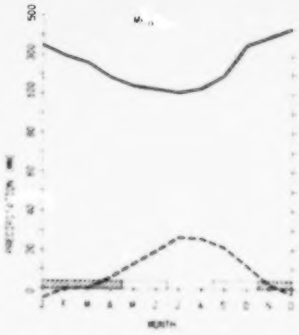
HANEY LOON LK 354 M 8.3 C 2882 MM
9-11 YRS RECORD



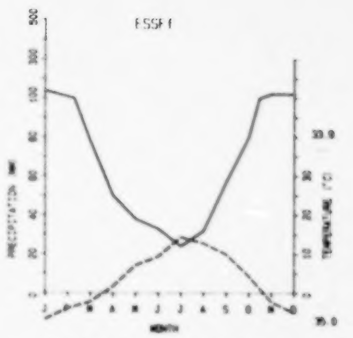
ALTA LK 668 M 5.7 C 1415 MM
20-25 YRS RECORD



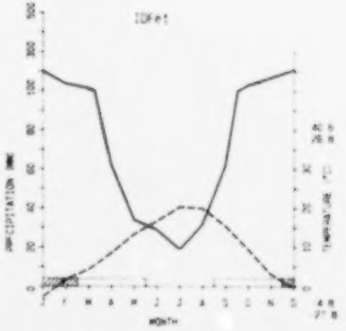
KEMANO KILDALA PASS 1609 m   -1.7 C   2743 mm
5-6 YRS RECORD END 1958



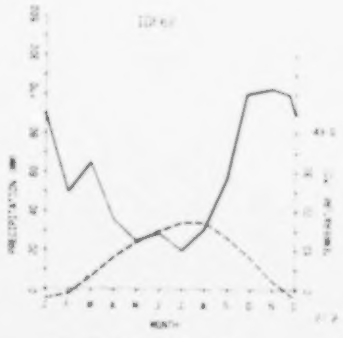
HOLLYBURN RIDGE 951 m   [illegible] C   2954 mm
19-26 YRS RECORD



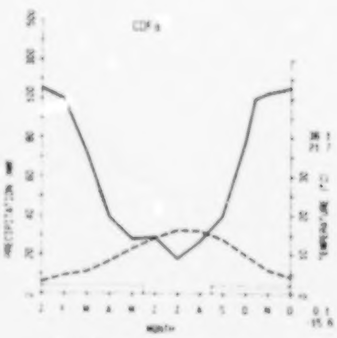
MANNING PK LODGE 1173 m   3.3 C   [illegible] mm
6 YRS RECORD END 1961



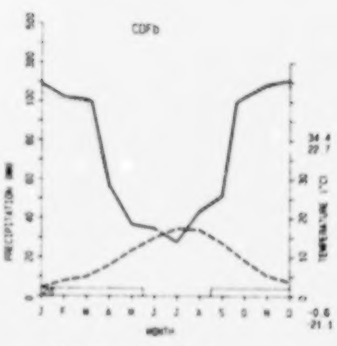
HELLS GATE 122 m   9.2 C   1199 mm
28-30 YRS RECORD



STUIE LODGE 140 m   7.8 C   729 mm
13-14 YRS RECORD END 1947



VICTORIA INT'L A 19 m   9.5 C   873 mm
40-41 YRS OF RECORD



COMOX A 24 m   9.4 C   1215 mm
36-37 YRS OF RECORD

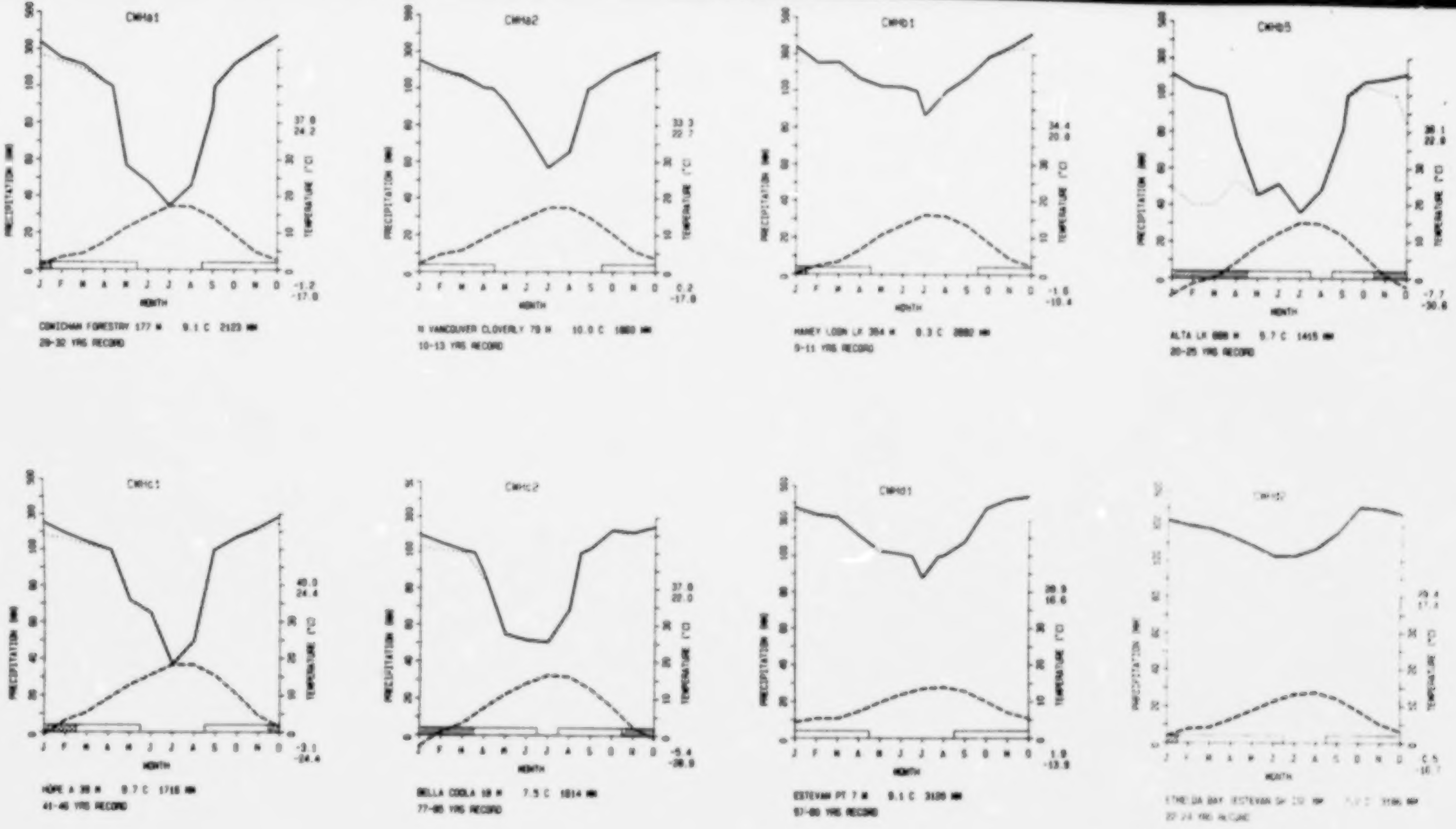


FIGURE 2. Climatic diagrams for biogeoclimatic subzones or variants for which there are published data (Anon. 1941, 1946, 1960; CCP 1981). Total monthly precipitation is shown bythe solid line, the amount falling as rain by the dotted line, and mean monthly temperature by a dashed line. Along the temperature axis from top to bottom are the absolute maximum, mean maximum, mean minimum, and absolute minimum temperatures (a dash represents unavailable data). The clear bars along the month axis indicate the period when the absolute minimum temperature falls below 0°C, the hatched bars show the period when the mean minimum temperature falls below 0°C, the hatched bars indicate the period when the mean minimum temperature falls below 0°C. Beside the station name is elevation, mean annual temperature, total annnual precipitation, and years of record.

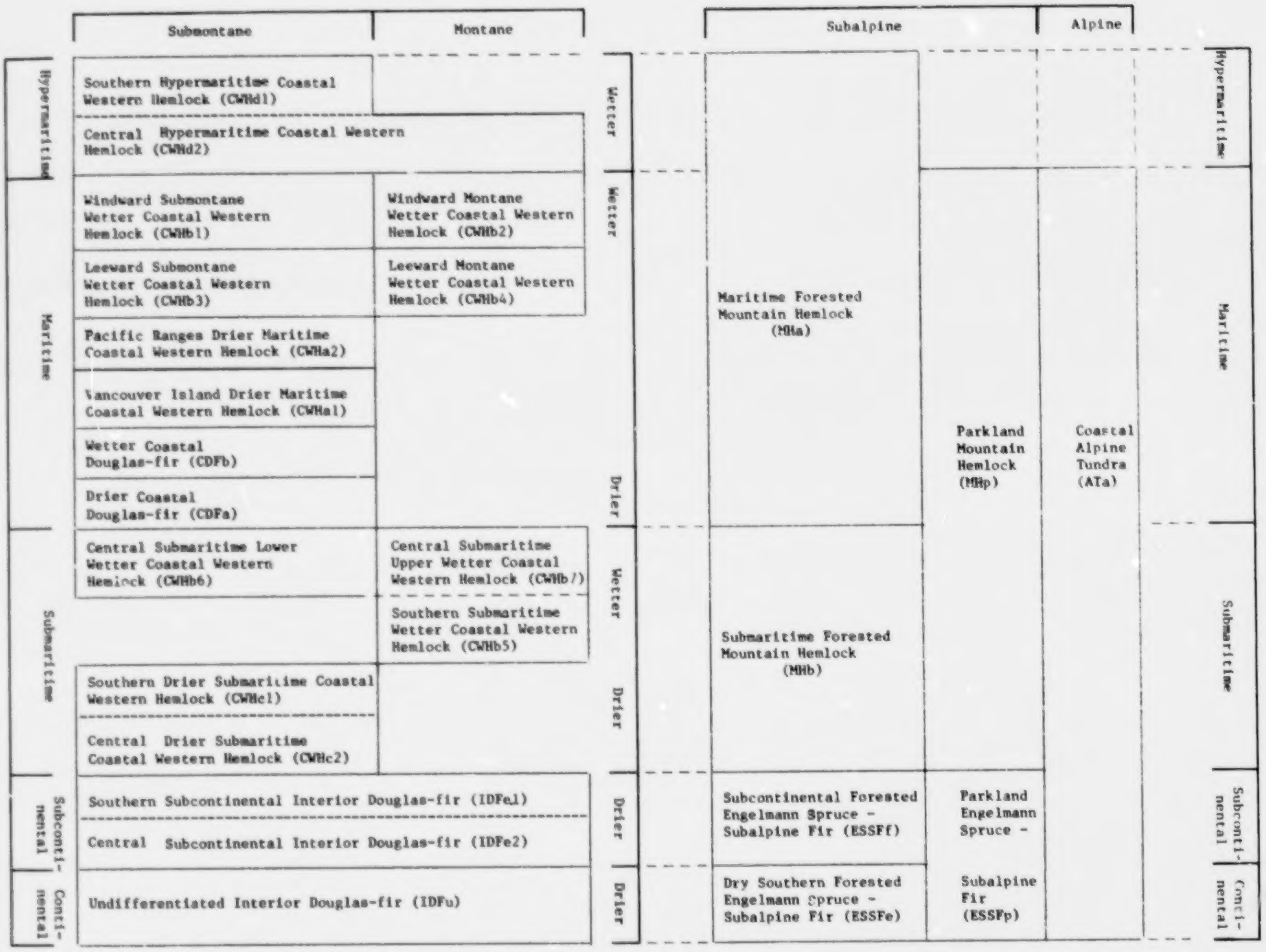

Submontane
Montane
Subalpine
Alpine
Hypermaritime
Maritime
Submaritime
Subcontinental
Continental
Wetter
Drier
Southern Hypermaritime Coastal Western Hemlock (CWHd1)
Central Hypermaritime Coastal Western Hemlock (CWHd2)
Windward Submontane Wetter Coastal Western Hemlock (CWHb1)
Windward Montane Wetter Coastal Western Hemlock (CWHb2)
Leeward Submontane Wetter Coastal Western Hemlock (CWHb3)
Leeward Montane Wetter Coastal Western Hemlock (CWHb4)
Pacific Ranges Drier Maritime Coastal Western Hemlock (CWHa2)
Vancouver Island Drier Maritime Coastal Western Hemlock (CWHa1)
Wetter Coastal Douglas-fir (CDFb)
Drier Coastal Douglas-fir (CDFa)
Central Submaritime Lower Wetter Coastal Western Hemlock (CWHb6)
Central Submaritime Upper Wetter Coastal Western Hemlock (CWHb7)
Southern Submaritime Wetter Coastal Western Hemlock (CWHb5)
Southern Drier Submaritime Coastal Western Hemlock (CWHc1)
Central Drier Submaritime Coastal Western Hemlock (CWHc2)
Southern Subcontinental Interior Douglas-fir (IDFe1)
Central Subcontinental Interior Douglas-fir (IDFe2)
Undifferentiated Interior Douglas-fir (IDFu)
Maritime Forested Mountain Hemlock (MHa)
Submaritime Forested Mountain Hemlock (MHb)
Parkland Mountain Hemlock (MHp)
Coastal Alpine Tundra (ATa)
Subcontinental Forested Engelmann Spruce - Subalpine Fir (ESSFf)
Dry Southern Forested Engelmann Spruce - Subalpine Fir (ESSFe)
Parkland Engelmann Spruce - Subalpine Fir (ESSFp)

FIGURE 3. Relationship between biogeoclimatic units and orographic element (alpine to submontane), degree of oceanic and continental influence (hypermaritime to continental), and precipitation regime for montane and submontane units (wetter to drier). A dashed line indicates that there is no difference between the units' precipitation regime. Figure 1 illustrates the locations of hypermaritime, maritime, submaritime and subcontinental areas.

Zone: **ALPINE TUNDRA (AT)**

Subzone: **COASTAL AT (ATa)**

Differentiating Characteristics:

-- zonal ecosystem association: Cassiope (mertensiana) - Phyllodoce (empetriformis)

Additional Characteristics:

-- non-forested ecosystems on high mountains.
-- Carex spp. and low-growing herbs such as Phlox diffusa present at lower limits in maritime and submaritime areas.
-- Hm, Ba, Yc are present at lower limits in maritime and submaritime areas; Bl and Pa in subcontinental areas.
-- only lichens, bryophytes and liverworts present in upper limits.
-- humus form/soil: Mormoder, Rhizomull/Humo-Ferric Podzol, Sombric Brunisol.
-- no edatopic grid is presented since there is no forestry use.

Climate: Kemano-Kildala Pass (Figure 2)

-- precipitation of driest month is 106 mm.
-- mean annual precipitation is 2743 mm, 71% falls as snow.
-- low temperature regime, possibility of frost in all months.
-- extremely short growing period for plants.

Distribution:

-- windward maritime Vancouver Island, > 1500 m; leeward maritime Vancouver Island, > 1650 m; adjacent mainland, > 1600 m; southern submaritime, > 1650 m; southern subcontinental, > 1850 m; southern continental, > 1950 m; north of Knight Inlet, maritime, > 1400 m; central submaritime, > 1550 m; central subcontinental, > 1750 m.
-- often interrupted by glaciers.

References:

-- Archer (1963), Brink (1959), Douglas and Bliss (1977).

Zone: **MOUNTAIN HEMLOCK (MH)**

Subzone: **PARKLAND MH (MHp)**

Differentiating Characteristics:

-- zonal ecosystem association: Hm - Vaccinium (membranaceum) - Rhododendron (albiflorum).

Additional Characteristics:

-- trees grow in clumps.
-- Ba, Yc present in maritime areas; Bl present in submaritime areas.
-- Carex nigricans, Cassiope mertensiana, Phyllodoce empetriformis present in openings on azonal ecosystems.
-- humus form/soil: Humimor/Ferro-Humic Podzol.
-- no edatopic grid is presented since logging is not viable.

Climate: no stations available.

-- expect climate to be intermediate between ATa and MHa (Figure 2).
-- snow survey summary at Sno-Bird Lake (Table 3) shows 234 cm of snow still present by 1 June.
-- extremely short growing period for plants.

Distribution:

-- windward maritime Vancouver Island (excluding northern tip), 1300-1500 m; leeward maritime Vancouver Island, 1350-1650 m; adjacent mainland, 1300-1600 m; southern submaritime 1400-1650 m; north of Knight Inlet and northern tip of Vancouver Island, maritime, 1200-1400 m; central submaritime, 1300-1550 m.

Reference:

-- Brooke et al. (1970).

Subzone: MARITIME FORESTED MH (MHa)

Differentiating Characteristics: (from MHb)

-- zonal ecosystem association: Hm - Ba - Vaccinium (membranaceum & alaskaense) - Rhytidiopsis (robusta).
-- differentiating species: Yc, Blechnum spicant, Blepharostoma trichophyllum, Cladonia bellidiflora, Dicranum fuscescens, D. scoparium, Diplophyllum taxifolium, Isopterygium elegans, Phyllodoce empetriformis, Rhytidiadelphus loreus.

Additional Characteristics:

-- major species in addition to those listed in the zonal ecosystem association are Hw, Yc, Dicranum fuscescens, D. scoparium, Menziesia ferruginea, Rhytidiadelphus loreus, Rubus pedatus.
-- tree cover on zonal ecosystems is continuous, not in clumps.
-- humus form/soil: Humimor/Ferro-Humic Podzol.
-- pattern of sites: Grid 1.

Climate: Hollyburn Ridge (Figure 2)

-- precipitation of driest month is 107 mm.
-- mean annual precipitation is 2954 mm, 28% falls as snow.
-- snow survey summary at Mt. Seymour (Table 3) shows 362 cm still present by 1 June.
-- low temperature regime; 2119 degree days > 0°C; six months have a mean minimum temperature below 0°C.
-- short growing period for plants.
-- range between minimum winter and maximum summer means is 15.5°C.

Distribution:

-- windward maritime Vancouver Island (excluding northern tip), 950-1300 m; leeward maritime Vancouver Island, 1100-1350 m; adjacent mainland, 1000-1300 m; northern tip of Vancouver Island, 900-1200 m; north of Knight Inlet, maritime, 850-1200 m.

Reference:

-- Brooke *et al.* (1970).

Subzone: SUBMARITIME FORESTED MH (MHb)

Differentiating Characteristics: (from the MHa)

- zonal ecosystem sssociation: Hm - Ba - Vaccinium (membranaceum & ovalifolium) - Rhytidiopsis (robusta).
- differentiating species: *Dicranum pallidisetum*.
- the absence or low frequency of differentiating species is diagnostic.

Additional Characteristics:

- major species in addition to those listed in the zonal ecosystem association are Hw, *Dicranum pallidisetum*, *Menziesia ferruginea*, *Rubus pedatus*, *Vaccinium alaskaense*.
- tree cover or zonal ecosystems is continuous, not in clumps; Bl is present.
- humus form/soil: Hemihumimor/Ferro-Humic, Humo-Ferric Podzol.
- steep south-facing slopes may resemble ESSF Zone (e.g. in upper limits of Cheakamus R.) but this is a topoedaphic effect.
- pattern of sites: Grid 2.

Climate: no stations available.

- expect climate to be intermediate between MHa and ESSFf (Figure 2).

Distribution:

- southern submaritime, 1200-1400 m; central submaritime, 1000-1300 m.

Zone: **ENGELMANN SPRUCE - SUBALPINE FIR (ESSF)**

Subzone: **PARKLAND ESSF (ESSFp)**

Differentiating Characteristics:

-- zonal ecosystem association: Se & Bl - Hm - Vaccinium (membranaceum) - Phyllodoce (empetriformis).

Additional Characteristics:

-- trees grow in clumps.
-- Hm and Ba present near western limits of subzone where Se may be rare.
-- Pa, La, Pl are often present as successional species.
-- humus form/soil: Hemihumimor/Humo-Ferric, Ferro-Humic Podzol.
-- no edatopic grid is presented since logging is not viable.

Climate: no stations available.

-- expect climate to resemble ESSFf (Figure 2) but with a lower temperature regime.
-- snow survey summary at Tenquille Lk. (Table 3) shows 198 cm still present by 1 June.

Distribution:

-- southern subcontinental, 1650-1850 m; southern continental, 1750 - 1950 m; central subcontinental, 1550-1750 m.

Subzone: SUBCONTINENTAL FORESTED ESSF (ESSFf)

Differentiating Characteristics: (from other forested ESSF subzones)

- zonal ecosystem association: Se - Bl & Ba - Vaccinium (membranaceum) - Rhytidiopsis (robusta).
- differentiating species: Dicranum pallidisetum, Rhytidiopsis robusta, Rubus pedatus, Sorbus scopulina, Tiarella unifoliata.

Additional Characteristics:

- tree cover on zonal ecosystems is continuous, not in clumps.
- Hm and Ba present near the western limits of the subzone where Se may be rare.
- Pl is often present as a successional species.
- humus form/soil: Hemimor, Hemihumimor/Humo-Ferric Podzol.
- steep north-facing slopes and upper reaches of narrow valleys may resemble MH Zone (e.g., Utzlius Ck.) but this is a topoedaphic effect.
- pattern of sites: Grid 3.

Climate: Manning Park (Figure 2)

- precipitation of driest month is 24 mm.
- mean annual precipitation is 885 mm, 58% falls as snow.
- snow survey summary at Lightning Lk. (Table 3) shows 79 cm still present by 1 May but none by 1 June.
- low temperature regime; five months have a mean minimum temperature below 0°C.
- range betwen minimum winter and maximum summer means is 21.1°C.

Distribution:

- southern subcontinental, 1350-1650 m; central subcontinental, 1200 - 1550 m.

Subzone: DRY SOUTHERN FORESTED ESSF (ESSFe)

Differentiating Characteristics: (from the ESSFf)

-- zonal ecosystem association: Se - Bl - Vaccinium (membranaceum) - Rhododendron (albiflorum).
-- differentiating species: Arnica cordifolia, Calamagrostis rubescens, Fragaria vesca, Pedicularis racemosa, Vaccinium scoparium.
-- the absence of Ba, Hm, Vaccinium ovalifolium is diagnostic.

Additional Characteristics:

-- major species in addition to those listed in the zonal ecosystem association are Paxistima myrsinites, Rhytidiopsis robusta, Rubus pedatus.
-- tree cover on zonal ecosystems is continuous, not in clumps.
-- humus form/soil: Hemimor/Humo-Ferric Podzol.
-- pattern of sites: included in Grid 3.

Climate: no stations available.

-- expect lower precipitation and temperature regimes than for ESSFf (Figure 2).
-- snow survey summary at Bralorne (Table 3) shows 24 cm still present by 1 May but none by 1 June.
-- plant growth will probably be restricted due to moisture deficits.

Distribution:

-- southern continental 1450-1750 m.

Reference:

-- McLean (1970).

Zone: **INTERIOR DOUGLAS-FIR (IDF)**

Subzone: **SUBCONTINENTAL IDF (IDFe)**

Differentiating Characteristics: (from other IDF subzones)

- zonal ecosystem association: Fd - Hw - Vaccinium (membranaceum) - Paxistima (myrsinites).
- differentiating species (tentative): *Clintonia uniflora*, *Rosa gymnocarpa*, *Vaccinium membranaceum*.

Additional Characteristics:

- major species in addition to those listed in the zonal ecosystem association is *Rhytidiadelphus triquetrus*.
- Fd is probably the interior variety.
- Hw and Cw are present, Hw has poor vigour and is restricted to zonal and wetter ecosystems.
- Pl is often present as a successional species.

Variant: **SOUTHERN IDFe (IDFe1)**

Differentiating Characteristics: (from IDFe2)

- differentiating species (tentative): *Spiraea betulifolia*, *Trientalis latifolia*.

Characteristics:

- Py may be present on drier-than-zonal ecosystems.
- humus form/soil: Hemimor, Mormoder/Dystric Brunisol.
- pattern of sites: Grid 4.

Climate: Hells Gate (Figure 2)

- precipitation of driest month is 19 mm.
- hot summers (20.4°C warmest month mean, to 40.6°C absolute); 3638 degree days > 0°C.
- three winter months with mean minimum temperature below 0°C.
- mean annual precipitation is 1199 mm, 16% falls as snow.
- range between minimum winter and maximum summer means is 23.0°C.

Distribution:

-- southern subcontinental, valley bottom, 1000 m; southern continental, 800-1450 m.

Variant: CENTRAL IDFe (IDFe2)

Differentiating Characteristics: (from IDFe1)

-- differentiating species (tentative): none, the absence or low frequency of differentiating species is diagnostic.

Additional Characteristics: (limited information available for this unit)

-- Py is not present, Se or Sw, Pl may be present.
-- humus form/soil: Hemimor, Mormoder/Dystric Brunisol.
-- pattern of sites: Grid 5.

Climate: Stuie Lodge (Figure 2)

-- precipitation of driest month is 20 mm.
-- hot summer (17.2°C warmest month mean, 43.0°C absolute).
-- mean annual precipitation is 729 mm, 18% falls as snow.
-- range between minimum winter and maximum summer means is 19.4°C.

Distribution:

-- central subcontinental, valley bottom, 1000 m.

Subzone: UNDIFFERENTIATED IDF (IDFu)[1]

Differentiating Characteristics:

-- differentiating species (tentative): none, the absence of differentiating species listed for IDFe is diagnostic.

Additional Characteristics:

-- Fd is interior variety; Hw and Cw are absent.
-- major species are Calamagrostis rubescens, Spiraea betulifolia.
-- Py occurs on drier-than-zonal ecosystems at lower elevations in the southern continental areas.
-- humus form/soil: Mormoder, Hemimor/Brunisol, Luvisol.
-- pattern of sites: included in Grid 4.

Climate:

-- no data presented due to the uncertainty of classification of this unit.
-- precipitation and temperature regimes will likely be lower than for IDFe1 (Figure 2).

Distribution:

-- southern continental, in Anderson Lk. area and Fraser Valley north of Boston Bar, valley bottom - 800 m.

Reference:

-- Annas and Coupe (1979), McLean (1970).

---

[1] Classification of this unit will be formalized following completion of data collection in adjacent forest regions.

Zone: **COASTAL DOUGLAS-FIR (CDF)**

Subzone: **DRIER CDF (CDFa)**

Differentiating Characteristics:

- zonal ecosystem association: Fd - Gaultheria (shallon) - Mahonia (nervosa).

Additional Characteristics:

- much of the area of this unit is urban; this plus logging disturbance makes climax zonal ecosystems rare.
- Fd is coastal variety, Hw is absent from zonal ecosystems.
- Qg is scattered on zonal and drier ecosystems, its major occurrence is in this subzone.
- humus form/soil: Leptomoder, Mormoder/Dystric Brunisol.
- pattern of sites: Grid 6.

Climate: Victoria International Airport (Figure 2)

- precipitation of driest month is 18 mm.
- warm summers (16.3°C warmest month mean, 36.1°C absolute); 3550 degree days > 0°C.
- mild winters, no month with a mean minimum below 0°C.
- mean annual precipitation is 873 mm, 6% falls as snow.
- range between minimum winter and maximum summer means is 13.2°C.

Distribution:

- below 150 m near coast in leeward maritime, south of Bowser and Lund.

Reference:

- Roehmer (1972).

Subzone: WETTER CDF (CDFb)

Differentiating Characteristics:

- zonal ecosystem association: Fd - Hw - Gaultheria (shallon).

Additional Characteristics:

- Fd is coastal variety, Hw is present but has poor vigor and is restricted to zonal and wetter ecosystems.
- humus form/soil: Mormoder, Hemimor/Dystric Brunisol, Humo-Ferric Podzol.
- pattern of sites: Grid 6.

Climate: Comox Airport (Figure 2)

- precipitation of driest month is 28 mm.
- moderate summer temperature (17.4°C warmest month mean, 34.4°C absolute); 3459 degree days > 0°C.
- mild winters, one month with a mean minimum below 0°C.
- mean annual precipitation is 1215 mm, 9% falls as snow.
- range between minimum winter and maximum summer means is 15.2°C.

Distribution:

- east coast of southern and central Vancouver Island, to Campbell River; across adjacent inland passage islands; Sunshine Coast to north of Theodosia Inlet; lower Fraser Valley, mostly south of Fraser River, to Chilliwack; 150 m (if CDFa occurs) or 0 - 450 m.

Reference:

- McMinn (1961).

Zone: **COASTAL WESTERN HEMLOCK (CWH)**

Subzone: **DRIER MARITIME CWH (CWHa)**

Differentiating Characteristics: (from other CWH subzones)

- zonal ecosystem association: Hw - Fd - Rhytidiadelphus (loreus) - Hylocomium (splendens).
- differentiating species: *Achlys triphylla*, *Mahonia nervosa*, *Polystichum munitum*, *Pteridium aquilinum*, *Rubus ursinus*, *Viola sempervirens*.

Additional Characteristics:

- major species in addition to those listed in the zonal ecosystem association are Cw, *Achlys triphylla*, *Gaultheria shallon*, *Kindbergia oregana*, *Mahonia nervosa*, *Polystichum munitum*, *Vaccinium parvifolium*.

Variant: **VANCOUVER ISLAND CWHa (CWHa1)**

Differentiating Characteristics: (from CWHa2)

- differentiating species: *Achlys triphylla*, *Rosa gymnocarpa*, *Tiarella trifoliata*.

Additional Characteristics:

- major species in addition to those listed in the zonal ecosystem association are Cw, *Achlys triphylla*, *Kindbergia oregana*, *Polystichum munitum*, *Vaccinium parvifolium*.
- Pw occurs, usually on drier-than-zonal ecosystems, Bg is present in southern part of variant but absent in Nimpkish R. valley.
- humus form/soil: Hemihumimor/Humo-Ferric Podzol.
- pattern of sites: Grid 7.

Climate: Cowichan Forestry (Figure 2)

- precipitation of driest month is 35 mm.
- warm summers (17.4°C warmest month mean, 37.8°C absolute); 3360 degree days > 0°C.
- mild winters, one month with a mean minimum temperature below 0°C.
- mean annual precipitation is 2123 mm, 7% falls as snow.
- range between minimum winter and maximum summer means is 16.0°C.

Distribution:

-- southern Vancouver Island, Discovery Passage Islands to West Thurlow Is., Gulf Is. high prominences, >450 m (if CDFa occurs) or 0 - 700 m; Nimpkish and Gold R. areas, valley bottom - 500 m.

References:

-- Kojima and Krajina (1975), McMinn (1961).

Variant: PACIFIC RANGES CWHa (CWHa2)

Differentiating Characteristics: (from CWHa1)

-- differentiating species: Acer circinatum, Blechnum spicant, Cornus nuttallii, Dicranum fuscescens, Plagiothecium undulatum, Taxus brevifolia.

Additional Characteristics:

-- major species in addition to those listed in the zonal ecosystem association are Cw, Gaultheria shallon, Kindbergia oregana, Polystichum munitum.
-- Pw occurs, usually on drier-than-zonal ecosystems, Bg occurs on wetter- and richer-than-zonal ecosystems.
-- humus form/soil: Hemihumimor/Humo-Ferric Podzol.
-- pattern of sites: Grid 8.

Climate: North Vancouver Cloverly (Figure 2)

-- precipitation of driest month is 57 mm.
-- warm summers (17.6°C warmest month mean, 33.3°C absolute).
-- mild winters, no month with a mean minimum temperature below 0°C.
-- mean annual precipitation is 1860 mm, 5% falls as snow.
-- range between minimum winter and maximum summer means is 15.2°C.

Distribution:

-- windward maritime on mainland, includes only immediately adjacent inland passage islands, north to Phillips L. (draining into Phillips Arm), 450 m (if CDFb occurs) or 0-650 m.

References:

-- Klinka (1976), Orloci (1961, 1965).

Subzone: WETTER CWH (CWHb)

Differentiating Characteristics: (from other CWH subzones)

-- zonal ecosystem association: Hw - Ba - Vaccinium (alaskaense) - Rhytidiadelphus (loreus).
-- differentiating species: none, the absence or low frequency of differentiating species is diagnostic.

Additional Characteristics:

-- major species in addition to those listed in the zonal ecosystem association are Cw, Hylocomium splendens, Rhytidiopsis robusta, Vaccinium parvifolium.

Variant: WINDWARD SUBMONTANE MARITIME CWHb (CWHb1)

Differentiating Characteristics:

-- differentiating species: none.

Additional Characteristics:

-- Blechnum spicant and Gaultheria shallon are more abundant and Fd is less abundant in this variant than in others; can be distinguished from the CWHb2 by the absence of Yc and Rhytidiopsis robusta.
-- major species in addition to those listed in the zonal ecosystem association are Cw, Blechnum spicant, Gaultheria shallon, Hylocomium splendens, Vaccinium parvifolium.
-- humus form/soil: Humimor, Hemihumimor/Ferro-Humic, Humo-Ferric Podzol.
-- pattern of sites: Grid 9.

Climate: Haney, Loon Lake (Figure 2)

-- precipitation of driest month is 87 mm.
-- warm summers (16.3°C warmest month mean, 34.4°C absolute); 3081 degree days > 0°C.
-- mild winters, one month with a mean minimum below 0°C.
-- mean annual precipitation is 2682 mm, 8% falls as snow.
-- range between minimum winter and maximum summer means is 16.3°C.

Distribution:

-- windward maritime Vancouver Island (excluding northern tip), above CWHd1 if present (150 m), to sea level otherwise and below 600 m; on adjacent mainland above CDFb (150 m, 450 m if CDFa is present) or above CWHa2 (450 m) if present, to sea level otherwise and below 650 m; northern tip of Vancouver Island, above CWHd1 (if less than 600 m), to sea level otherwise and below 600 m; north of Knight Inlet, above CWHd1 (if less than 550 m), to sea level otherwise and below 550 m.

Reference:

-- Klinka (1976), Orloci (1961, 1965).

Variant: WINDWARD MONTANE MARITIME CWHb (CWHb2)

Differentiating Characteristics:

-- differentiating species: none.

Additional Characteristics:

-- can be distinguished from the CWHb1 which lies below by greater Yc than Cw cover and an increase in cover of Rhytidiopsis robusta.
-- major species in addition to those listed in the zonal ecosystem association are Cw, Yc, Hylocomium splendens, Rhytidiopsis robusta, Vaccinium parvifolium.
-- humus form/soil: Humimor/Humo-Ferric, Ferro-Humic Podzol.
-- pattern of sites: Grid 10.

Climate: no stations available

-- expect precipitation and temperature regimes to be intermediate between CWHb1 and MHa (Figure 2).

Distribution:

-- western and northern Vancouver Island, windward maritime, 600-900 m; adjacent mainland, 650 - 1000 m; north of Knight Inlet, maritime, 550-850 m.

Reference:

-- Klinka (1976), Orloci (1961, 1965).

Variant: LEEWARD SUBMONTANE MARITIME CWHb (CWHb3)

Differentiating Characteristics:

-- differentiating species: none.

Additional Characteristics:

-- can be distinguished from the CWHb4 which lies above by greater cover of Gaultheria shallon and Polystichum munitum, and by the absence or low frequency of Yc and Gaultheria ovatifolia.
-- major species in addition to those listed in the zonal ecosystem association are Cw, Fd, Hylocomium splendens, Vaccinium parvifolium.
-- fires have occurred frequently in this variant, thus, Ba is reduced while Fd is more common here than in all other CWHb variants in maritime areas.
-- humus form/soil: Humimor, Hemihumimor/Humo-Ferric Podzol.
-- pattern of sites: Grid 11.

Climate: no stations available.

-- expect precipitation and temperature regimes to be intermediate between those of the CWHa1 and CWHb1 (Figure 2).
-- Vancouver Is. mountains create a rainshadow.

Distribution:

-- leeward maritime, 500-700 m; has a discontinuous distribution in the upper parts of narrow valleys on the east slope of Beaufort Ridge, and at Forbidden Plateau.

Reference:

-- Kojima and Krajina (1975).

Variant: LEEWARD MONTANE MARITIME CWHb (CWHb4)

Differentiating Characteristics: (from other CWHb variants)

-- differentiating species: Yc, Gaultheria ovatifolia, Linnaea borealis, Mahonia nervosa.

Additional Characteristics:

- of the above species, only the latter is absent from the adjoining CWHb2, while the others have a low frequency of occurrence; can be further distinguished from the CWHb2 by the increased frequency and cover of *Orthilia secunda*, and, due to a fire history, the reduced frequency and cover of Ba and increase in Fd.
- major species in addition to those listed in the zonal ecosystem association are Fd, *Rhytidiopsis robusta*.
- Bl (on limestone and talus), Pw, *Rhododendron albiflorum*, *Paxistima myrsinites* occur at higher elevations of this variant.
- humus form/soil: Humimor/Humo-Ferric Podzol.
- pattern of sites: Grid 12.

Climate: no stations available.

- expect precipitation and temperature regimes to be intermediate between CWHa1 and MHa (Figure 2).

Distribution:

- leeward maritime, 700-1100 m.

Variant: SOUTHERN SUBMARITIME CWHb (CWHb5)

Differentiating Characteristics: (from other CWHb variants)

- differentiating species: *Dicranum pallidisetum*, *Paxistima myrsinites*, *Pleurozium schreberi*, *Tiarella unifoliata*, *Vaccinium membranaceum*.

Additional Characteristics:

- can be further distinguished from the CWHb1 and b2 which adjoin, by the absence or low frequency of *Blechnum spicant* and *Gaultheria shallon*, and by the increased frequency and cover of Fd, *Clintonia uniflora*, *Orthilia secunda*.
- major species are Cw, Fd, *Hylocomium splendens*, *Pleurozium schreberi*, *Rhytidiopsis robusta*.
- Bl occasionally occurs on drier- and wetter-than-zonal ecosystems.
- humus form/soil: Hemihumimor/Humo-Ferric Podzol.
- pattern of sites: Grid 13.

Climate: Alta Lk. (Figure 3)

- -- represents the lower limit of the variant.
- -- precipitation of driest month is 36 mm.
- -- warm summers (15.3°C warmest month mean, 36.1°C absolute); 2449 degree days > 0°C.
- -- cool winters, six months with a mean minimum temperature below 0°C.
- -- mean annual precipitation is 1415 mm, 43% falls as snow.
- -- range between minimum winter and maximum summer mean is 19.7°C.

Distribution:

- -- southern submaritime, 650-1200 m; southern subcontinental, 1000-1350 m.

Variant: CENTRAL SUBMARITIME LOWER CWHb (CWHb6)

Differentiating Characteristics: (from other CWHb variants)

- -- differentiating species (tentative): Dicranum fuscescens and Rhytidiadelphus triquetrus.

Additional Characteristics:

- -- can be further distinguished from the CWHb7, which lies above, by the high frequency of Fd and Chimaphilla menziesii; and the low frequency and cover of Ba; and from the CWHb5 which occurs to the south by the absence or low frequency of differentiating species listed for that Variant.
- -- major species are Cw, Fd, Cornus unalaschkensis, Hylocomium splendens.
- -- humus form/soil: Hemimor, Hemihumimor/Humo-Ferric Podzol.
- -- pattern of sites: Grid 14.

Climate: no stations available.

- -- expect precipitation regime to be wetter and temperature regime to be cooler than for CWHc2 (Figure 2).

Distribution:

- -- central submaritime, narrow valleys adjoining major (e.g. Bella Coola and Dean valleys), 0-450 m.

Variant: CENTRAL SUBMARITIME UPPER CWHb (CWHb7)

Differentiating Characteristics: (From other CWHb variants)

-- differentiating species (tentative): Gymnocarpium dryopteris and Pogonatum sylvaticum.

Additional Characteristics: (limited information available for this Variant)

-- can be further distinguished from the CWHb6, which lies below, by the absence or low frequency and cover of Fd and Chimaphila menziesii and by the high frequency and cover of Ba; and from the CWHb5, which occurs to the south, by the absence or low frequency of differentiating species listed for that variant and by the occurrence of Ss on azonal ecosystems.
-- major species are Ba, Clintonia uniflora, Hylocomium splendens, Gymnocarpium dryopteris.
-- Bl occasionally occurs on drier- and wetter-than-zonal ecosystems.
-- humus form/soil: Humimor, Hemihumimor/Ferro-Humic, Humo-Ferric Podzol.
-- pattern of sites: Grid 15.

Climate: no stations available.

-- expect climate to be similar to CWHb5 (Figure 2), the southern counterpart of this variant.

Distribution:

-- central submaritime, 450-1050 m.

Subzone: DRIER SUBMARITIME CWH (CWHc)

Differentiating Characterisics: (from other CWH subzones)

-- zonal ecosystem association: Hw - Fd - Hylocomium (splendens) - Rhytidiadelphus (triquetrus).

-- differentiating species: Acer glabrum, Betula papyrifera, Chimaphila umbellata, Clintonia uniflora, Goodyera oblongifolia, Paxistima myrsinites, Pleurozium schreberi, Pyrola asarifolia, Rhytidiadelphus triquetrus.

Additional Characteristics:

-- major species in addition to those listed in the zonal ecosystem association is Cw.

Variant: SOUTHERN CWHc (CWHc1)

Differentiating Characteristics:

-- differentiating species: none, insufficient data from CWHc2.

Additional Characteristics:

-- major species in addition to those listed in the zonal ecosystem association are Cw, Linnaea borealis, Paxistima myrsinites, Pleurozium schreberi, Rhytidiopsis robusta, Taxus brevifolia.

-- humus form/soil: Hemimor, Hemihumimor/Humo-Ferric Podzol, Dystric Brunisol.

-- pattern of sites: Grid 16.

Climate: Hope Airport (Figure 2)

-- precipitation of driest month is 37 mm.

-- warm summers (18.5°C warmest month mean, 40.0°C absolute); 3686 degree days > 0°C.

-- cool winters, three months with a mean minimum temperature below 0°C.

-- mean annual precipitation is 1716 mm, 10% falls as snow.

-- range between minimum winter and maximum summer means is 18.9°C.

Distribution:

-- southern submaritime, valley bottom to 650 m.

Variant: CENTRAL CWHc (CWHc2)

Differentiating Characteristics:

-- differentiating species: none, insufficient data from this variant.

Additional Characteristics: (limited information available for this variant)

-- major species in addition to those listed in the zonal ecosystem association are Cw, Clintonia uniflora.
-- humus form/soil: Hemimor, Hemihumimor/Humo-Ferric Podzol, Dystric Brunisol.
-- pattern of sites: Grid 17.

Climate: Bella Coola (Figure 2)

-- precipitation of driest month is 51 mm.
-- warm summer temperatures (16.5°C warmest month mean, 37.8°C absolute); 2980 degree days > 0°C.
-- cool winters, five months with a mean maximum temperature below 0°C.
-- mean annual precipitation is 1614 mm, 12% falls as snow.
-- range between minimum winter and maximum summer means is 19.3°C.

Distribution:

-- central submaritime, 0-500 m.

Subzone: HYPERMARITIME CWH (CWHd)

Differentiating Characteristics: (from other CWH subzones)

- zonal ecosystem association: Hw - Cw - Gaultheria (shallon) - Rhytidiadelphus (loreus).
- differentiating species: *Blechnum spicant*, *Listera cordata*, *Maianthemum dilatatum*, *Menziesia ferruginea*, *Rhizomnium glabrescens*, Ss, *Plagiothecium undulatum*, *Scapania bolanderi*, *Sphagnum girgensohnii*.

Additional Characteristics:

- major species in addition to those listed in the zonal ecosystem association are *Blechnum spicant*, *Hylocomium splendens*, *Menziesia ferruginea*, *Vaccinium parvifolium*, *V. alaskaense*.

Variant: SOUTHERN CWHd (CWHd1)

Differentiating Characteristics: (from CWHd2)

- differentiating species: Ba.

Additional Characteristics:

- major species in addition to those listed in the zonal ecosystem association are Ba, *Blechnum spicant*, *Hylocomium splendens*, *Kindbergia oregana*, *Menziesia ferruginea*, *Vaccinium alaskaense*, *V. parvifolium*.
- humus form/soil: Humimor/Ferro-Humic Podzol.
- pattern of sites: Grid 18.

Climate: Estevan Point (Figure 2)

- wet, foggy summers, precipitation of driest month is 88 mm.
- cool summer temperatures (14.1°C warmest month mean, 28.9°C absolute); 3354 degree days > 0°C.
- mild winters (1.9°C is mean minimum of coldest month).
- mean annual precipitation is 3120 mm, 2% falls as snow.
- range between minimum winter and maximum summer means is 9.6°C.

Distribution:

- southern hypermaritime, south of Brooks Peninsula, 0-150 m, north of Holberg Inlet, 0-600 m.

Reference:

- Cordes (1972).

Variant: CENTRAL CWHd (CWHd2)

Differentiating Characteristics: (from CWHd1)

- differentiating species: Yc, Ss, *Cornus unalaschkensis*, *Hookeria lucens*, *Listera banksiana*, *Listera cordata*, *Lysichitum americanum*, *Rhizomnium glabrescens*.

Additional Characteristics:

- major species in addition to those listed in the zonal ecosystem association are Yc, *Blechnum spicant*, *Hylocomium splendens*, *Menziesia ferruginea*, *Vaccinium alaskaense*, *V. parvifolium.*
- humus form/soil: Humimor/Ferro-Humic Podzol.
- pattern of sites: Grid 18.

Climate: Ethelda Bay (Figure 2)

- wet, foggy summers, precipitation of driest month is 126 mm.
- cool summers (13.7°C warmest month mean, 28.4°C absolute); 2988 degree days > 0°C.
- mild winters (-0.5°C is mean minimum of coldest month).
- mean annual precipitation is 3186 mm, 5% falls as snow.
- range between minimum winter and maximum summer means is 11.8°C.

Distribution:

- central hypermaritime areas, 0-600 m.

2.3.3 Hygrotope and Its Classification

Hygrotope (Pogrebnyak 1930) or soil (ecological) moisture regime is an inferred soil property defined as the capacity of a soil to supply available water for plant growth. It refers to the groundwater level or the amount of water held at a tension < 15 bars in the soil rooting zone.

Hygrotope is a function of soil, relief, and climate. Soil properties such as soil depth, texture, structure, content of coarse fragments, and content of organic matter, determine the water-holding capacity of a soil. However, the hygrotope will ultimately be determined by climatic inputs. Most soils receive their greatest input of water through precipitation but may lose part or most of it depending on their position in the landscape. Thus, similar soils in similar positions in the landscape may have different hygrotopes depending on the regional climate. This has led some workers to differentiate between a potential and actual hygrotope (Arbeitskreis Standortskartierung 1978); the former referring to the potential capacity of a soil to hold and lose or receive water as determined by its properties and position in the landscape, regardless of climate; the latter referring to the actual capacity of a soil to supply water for plant growth. This concept was adopted because it provides a rational basis for classification and it facilitates estimation of hygrotopes in the field.

Krajina (1969) approached classification of hygrotopes by combining climatope with one of the classes traditionally used to characterize hygrotope (Table 4). Within a given climatope, hygrotope was assessed qualitatively using diagnostic plant species, relief, and selected soil properties. He consistently applied these classes in different climatopes, such that the driest forested site in any biogeoclimatic subzone was called very xeric while the wettest was subhydric. This usage represented a ranking of ecosystems by potential hygrotopes which, when combined with climatope, inferred the actual supply of water (actual hygrotope).

TABLE 4. Classes of potential hygrotope (Krajina 1969)

Symbol	Name
0	very xeric
1	xeric
2	subxeric
3	submesic
4	mesic
5	subhygric
6	hygric
7	subhydric

A consequence of this approach was that a particular hygrotope class used in different biogeoclimatic units, denoted different actual hygrotopes. For example, a xeric class represents a considerably drier actual hygrotope in the CDFa Subzone than in the MHa Subzone, reflecting the different precipitation of the two subzones.

A classification of actual hygrotope is desired which would allow comparisons or general statements to be made about the soil moisture regime without having to make references to a particular climatope. A functional and quantitative approach to the characterization of hygrotopes has been proposed using variations in available water as it changes with the seasons, and by relationships to climate and plant growth. This approach, partly based on Thornthwaite's concept (Thornthwaite 1948, Thornthwaite and Mather 1955, Thornthwaite *et al.* 1957) of balancing precipitation added to ecosystems against losses by evapotranspiration was used to characterize soil moisture regimes by Barbour and Major (1977), Major (1963) and Soil Survey Staff (1975). In British Columbia, this approach was tested by Giles (1983) and is being studied for characterization of hygrotopes in different climates by the Ecological Program Staff, Vancouver Forest Region. A more detailed discussion of the approach can be found in Klinka *et al.* (1985)[1].

Nine classes on an absolute scale are recognized for actual hygrotope (Table 5). They should be referred to by their English adjectives but not by Arabic numbers, which have been reserved exclusively for potential hygrotopes[2]. The extremely dry, very dry, moderately dry, and slightly dry classes are differentiated by the duration of deficit. The fresh class represents a regime where there is a utilization phase but no deficit. The moist, very moist, wet and very wet classes represent saturated soil moisture regimes which are differentiated by the proximity of the groundwater table to the surface during the growing season. For practical purposes, the very moist and very wet classes are combined with the moist and wet classes, respectively. The wet class implies a reducing regime in association with the groundwater that is more or less free of dissolved oxygen.

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[1] Klinka, K., P.J. Courtin, and R.N. Green. 1985. An approach to quantitative classification of hygrotopes and trophotopes of forest soils. Province of British Columbia, Ministry of Forests, Victoria, B.C. (in manuscript).

[2] The Latin adjectives for hygrotopes (xeric through subhydric) have been proposed by Pogrebnyak (1930) and traditionally used in an absolute sense (Arbeitskreis Standortskartierung 1978, Bakuzis 1969, Dansereau 1957, Ellenberg 1982, Hills 1960, Svoboda 1949), and have been defined as such in 1979 in Webster's New Collegiate Dictionary. The application of these terms to a relative scale of soil moisture by Krajina (1969) was somewhat misleading, as a "xeric" site in a perhumid climate could, in fact, feature no water deficit. Thus, we recognize that Latin adjectives could be correctly used to name the nine proposed classes of actual hygrotopes. However, at this time, because of the historical use of Latin names on a relative scale in B.C., we recommend English adjectives only for naming these classes.

This proposed classification is tentative as the differentiating characteristics and recognized classes need to be substantiated by further studies. More studies are also needed to derive annual water balances for the majority of different forest sites. At present the actual hygrotopes presented on the edatopic grids were derived on the basis of their predicted relationship to climatope and potential hygrotope (Figure 4) and were inferred from indicator plant analyses. However, we believe that the conceptual base adopted will clarify the use of hygrotope in ecosystem or site classification as well as in studies on plant-environment relationships.

TABLE 5. The key to the identification of actual hygrotope

Criteria	Class of actual hygrotope
1a. Deficit occurs	
2a. Deficit > 4 months	EXTREMELY DRY
2b. Deficit > 2 months and ≤ 4 months	VERY DRY
2c. Deficit > 1 month and ≤ 2 months	MODERATELY DRY
2d. Deficit > 0 month and ≤ 1 month	SLIGHTLY DRY
1b. No deficit	
3a. Utilization occurs	FRESH
3b. No utilization	
4a. Groundwater table absent during the growing season	MOIST
4b. Groundwater table present during the growing season	
5a. Groundwater table > 30 cm deep	VERY MOIST
5b. Groundwater table ≤ 30 cm deep	WET
5c. Groundwater table at or above the ground surface	VERY WET

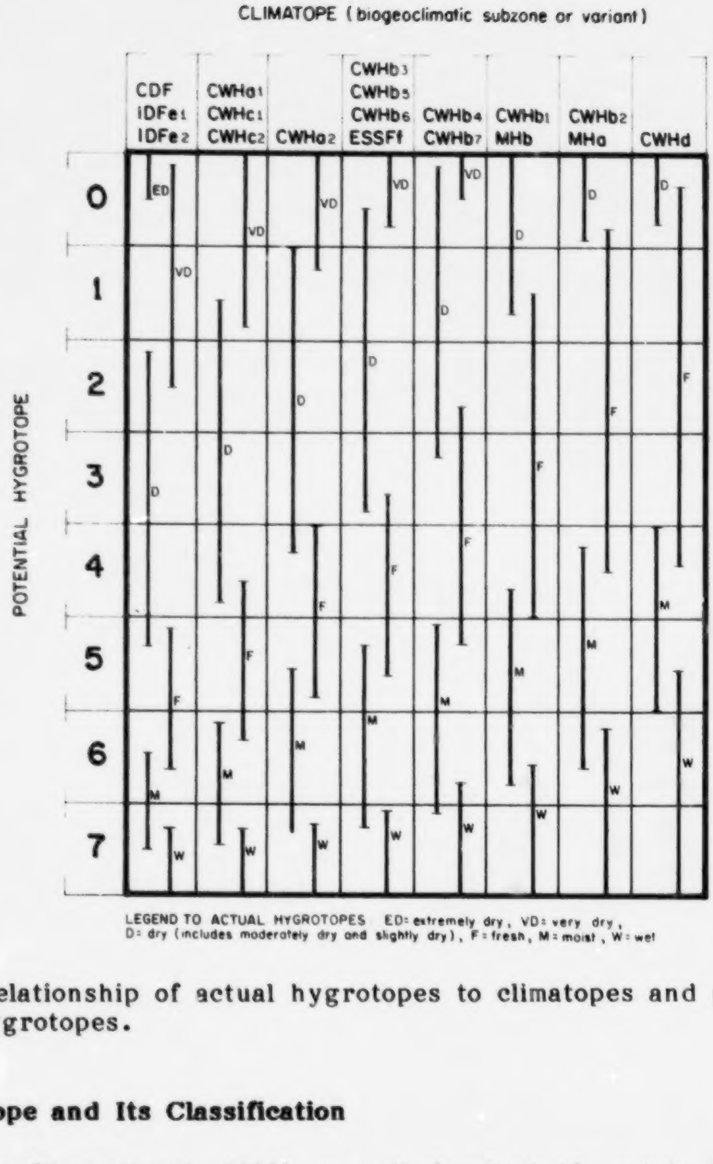

FIGURE 4. Relationship of actual hygrotopes to climatopes and potential hygrotopes.

2.3.4 Trophotope and Its Classification

Trophotope (Pogrebnyak 1930) or soil (ecological) nutrient regime is defined as the capacity of a soil to supply essential nutrients for plant growth. In contrast to hygrotope, which describes the capacity of a soil to supply water, trophotope addresses a much more complex subject - the amount and balance of available nutrients.

Trophotope, like hygrotope, is a function of soil, soil parent materials, organisms, climate, and relief. Inherent soil properties such as depth, texture, structure, content of coarse fragments, content of organic matter and porosity, which determine water-holding capacity, also determining the nutrient-holding capacity (nutrient storage) of a soil. Discussion of the relationship of these soil properties to trophotope can be found in Section 2.51.

There is a conceptual difference between hygrotope and trophotope. In the case of hygrotope, the soil does not have an inherent reserve of water; the water supply is essentially dependent on climatic inputs. Except for soils featuring a groundwater table, it is difficult to classify actual hygrotope from site properties without reference to climate. Therefore, we use the relationships between potential hygrotope, based on site properties, and climate to determine actual hygrotopes.

In contrast, soils have an inherent reserve of nutrients. This reserve is dynamic, some nutrients being removed through uptake or leaching while others are added either by weathering of minerals, decomposition of organic materials, seepage, flooding, and other factors. Thus, it is feasible to infer actual trophotope from directly observable soil properties, which can be related to the reserve and supply of nutrients. This eliminates the need for potential trophotope.

Krajina (1969) approached the classification of trophotope by combining climatope with one of the five classes traditionally used to characterize soil nutrient regime (Table 6). The trophotope classes for a given ecosystem or site were assessed qualitatively using diagnostic plants and selected environmental properties. Krajina (1969) consistently applied the same scale in combination with different climatopes and hygrotopes; that is, in a "relative" sense. For example, within any given biogeoclimatic subzone, the nutrient-poorest site was always called oligotrophic while the nutrient-richest site was called eutrophic. In consequence, a particular trophotope class, used in relation to different biogeoclimatic subzones, often denoted different soil nutrient supplies, owing largely to the influence of climate.

TABLE 6. Symbols and names used in classification of trophotopes

Symbol (Krajina 1969)	Name	
A	oligotrophic	nutrient-very poor
B	submesotrophic	nutrient-poor
C	mesotrophic	nutrient-medium
D	permesotrophic	nutrient-rich
E	subeutrophic to eutrophic	nutrient-very rich
F	hypereutrophic	nutrient-excessively rich

Although Krajina's trophotope classification was intended to be applied in a relative sense, it was in practice often applied in an absolute sense; that is, the five classes were used outside the context of climatope. The main reason for this was that actual trophotope could be inferred, at least in part, from site properties which reflected climatic influences.

Krajina's (1969) approach yielded a large number of soil nutrient regimes considering all possible climatope-trophotope combinations. We wish to reduce the number of these combinations for making comparisons or general statements about actual trophotopes outside boundaries of climatope. For this purpose we need a scale based on quantitatively characterized classes.

Those factors influencing trophotope do not behave independently; complex and subtle interrelationships between them complicates the evaluation of trophotope in the final analysis. Moreover, uncertainties about the methods of soil chemical analyses indexing the amounts of available nutrients or the difficulties determining external nutrient inputs through soil chemical analysis make the quantitative characterization of trophotope very difficult (e.g., Armson 1977, Ralston 1964). These difficulties have led some workers to emphasize a single factor, such as soil pH (e.g., Ellenberg 1982, Mayer 1977, Walmsley et al. 1980), or to suggest that biological tests, in which the growth and foliage analysis of crop plants occupying the site are examined, would give a better measure of trophotope (e.g., Armson 1977, Ballard and Carter 1983[1], Pritchett 1979, Tisdale and Nelson 1975).

Because of the complexity involved, difficulties with which some factors are measured, and inadequate knowledge on the subject, it is doubtful whether a complete and exact quantification of trophotope is possible. Assessments or estimates of trophotopes are, however, required for generalization or practical purposes. These difficulties notwithstanding, it is felt that rational assessments can be made, providing that the concept of trophotope is clarified and differentiating characteristics for its classification are determined.

In attempting to classify soil nutrient regimes, the approach has been to consider the soil chemical properties that could provide an index of the supply of essential nutrients for plant growth in the soil. Other considerations included analytical feasibility and estimation from morphological properties of the soil. Thus, the four properties chosen are:

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[1] Ballard, T.M. and R.E. Carter. 1983. Evaluating forest stand nutrient status. Faculty of Forestry, University of British Columbia, Vancouver, B.C. 76 p. (unpublished manuscript).

acidity (pH) and carbon:nitrogen ratio (C/N) of the humus form, and total soil nitrogen (TN) and sum of exchangeable calcium, magnesium, and potassium (SEB) both measured in kg/ha to rooting depth. The rationale for selecting these four properties as differentiating characteristics for the quantitative classification is based on their documented importance as constituents of the soil nutrient regime.

Numerous studies have concluded that humus forms (a) are recognizable by their morphological features, (b) are expressions of decomposition of organic materials at and near the surface of a pedon, and (c) provide an index of the supply of available nutrients. Nitrogen is one of the elements needed in the largest quantities by plants and one found to be most influential in increasing plant growth. Thus, the total soil nitrogen (kg/ha to rooting depth) was selected as an index of nitrogen reserve, as well as of other nutrients stored in the soil organic matter. It is suggested that the form and supply of available nitrogen is closely related to the humus form and amount of exchangeable bases of the soil. Calcium, magnesium, and potassium are also important macronutrients but rarely found to have been in deficient supply in the Pacific Northwest. Soil bases, calcium in particular, have been found indirectly associated with the soil nutrient regime through their influence on the acidity of soil solution, thereby affecting the form and solubility of other essential nutrients, decomposition of soil organic matter, and soil physical properties.

These four soil variables were used as differentiating characteristics in the classification of trophotopes. Using the data of Green (1984)[1], Klinka (1976), Klinka _et al_. (1981b) and Roy (1984), an analysis was conducted for a population of mesothermal soils in coastal southwestern British Columbia. The analysis yielded seven soil groups. These in turn were interpreted into classes of trophotope as shown in Table 7. More detailed information on the data analysis and classification methods can be found in Courtin _et al_. (1985)[2].

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[1] Green, R.N. 1984. Unpublished data. Province of British Columbia, Ministry of Forests, Vancouver Forest Region, Research Section.

[2] Courtin, P.J., K. Klinka and M.C. Feller. 1985. An approach to quantitative classification of nutrient regimes of forest soils. Province of British Columbia, Ministry of Forests, Victoria, B.C. (in manuscript).

TABLE 7. Means and standard deviations for TN, pH, C/N and SEB for the recognized soil groups and their classes of trophotope in coastal southwestern B.C.

Soil group	Trophotope class	Sample size	TN (Kg/ha)	pH (H_2O)	C/N	SEB (Kg/ha)
1	A	9	1743 (1785.7)	3.8 (0.25)	73 (7.4)	1386 (1683.5)
2	B	29	3010 (2421.0)	3.6 (0.27)	52 (5.3)	871 (763.6)
3	C_1	46	4593 (2102.1)	3.8 (0.30)	37 (3.5)	944 (775.6)
4	C_2	41	2045 (1268.3)	4.5 (0.29)	43 (4.1)	794 (345.9)
5	C_3	14	12989 (3749.1)	4.1 (0.62)	34 (6.8)	1255 (576.9)
6	D	39	4069 (2450.2)	4.5 (0.50)	20 (6.0)	1743 (1088.4)
7	E	17	8404 (3920.5)	5.0 (0.43)	21 (4.5)	5066 (1961.3)

This proposed classification is preliminary and requires further testing. This testing should also include examination of relationships between trophotopes, foliar nutrient levels, and vegetation and forest productivity. As the differentiating characteristics require analytical data, the classification will be restricted to research studies. In the field, trophotopes will be inferred from the synthesis of selected soil properties and integrated with indicator plant analysis.

2.3.5 Edatopic Grid

The edatopic grid of Alekseyev and Pogrebnyak (Pogrebnyak 1930, Rysin 1982) has been used as a tool to correlate ecotope and interpretative information for the tree species selection guidelines (Figure 5). In various modifications, this grid has been used by many ecologists to demonstrate relationships of plants or vegetation to soil moisture and nutrient regimes (e.g., Bakuzis 1969, Ellenberg 1982, Krajina 1969, Mayer 1977).

In this guide, the edatopic grid is composed of 40 cells (edatopes) resulting from all possible combinations between eight hygrotope classes and five trophotope classes. Sites are displayed on the grids according to their ecotope values; the biogeoclimatic unit (climatope) will determine the particular grid, and the hygrotope and trophotope classes will determine a particular position on the grid. The ecotope of a site or its location on the grid is referred to by the names or symbols used for climatope, hygrotope, and trophotope, e.g. CWHa2: fresh/nutrient-poor or CWHa2: 4/B. One should keep in mind, however, that when comparing the sites without reference to climatope, the numerical symbol designating potential hygrotope is irrelevant. In such cases, a combination of names for actual hygrotope and trophotope should be used, e.g., fresh/nutrient poor.

Because water is a key factor in the major mechanisms of nutrient uptake, sites with substantial water deficits did not qualify as nutrient-rich or very rich. Similarly, because of the influence of low soil temperature and/or high precipitation on nutrient availability and uptake, strongly drained sites influenced by cool and perhumid climates did not qualify as nutrient-rich or very rich. As a result, the grids depicting such ecological conditions show blank cells in the upper right corner, proportional to the predicted influence of these factors.

The cells or site units displayed on the grid do not indicate the distribution of edatopes in the region. Certain cells or even groups of cells may be very rare or even non-existent in some environmental settings. A more detailed description of the edatopic grids in relation to their interpretative content is given in Section 3.3.

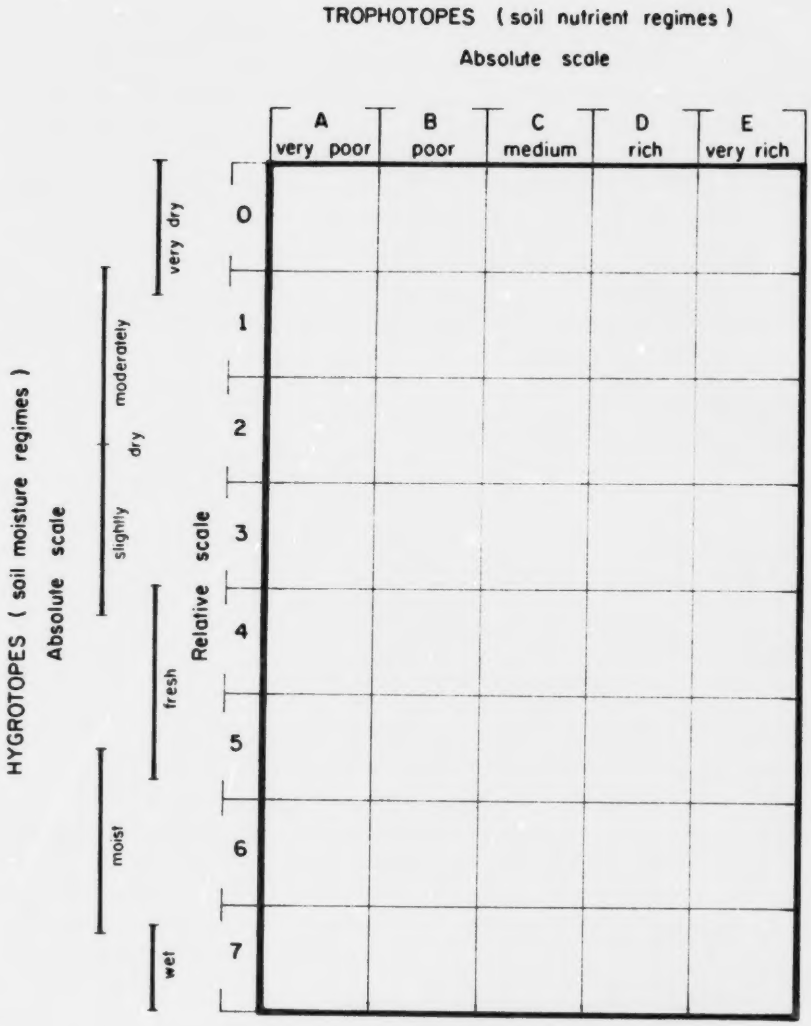

FIGURE 5. The edatopic grid.

2.4 Indicator Plant Species

2.4.1 Synopsis

Eighteen edatopic indicator species groups, including a total of 362 species, have been developed to facilitate the use of plants in forest site diagnosis in southwestern British Columbia. The groups include plant species that have similar distribution modes in relation to both actual hygrotope and actual trophotope. Each group is identified by a two-digit reference number. Due to differences in geographic distribution and responses to biotic or environmental factors (other than moisture and nutrients), the species of any group occur together only in specific combinations. The edatopic indicator groups are described and the list of species and their group membership is given in the appendix.

2.4.2 Introduction

Ecologists and foresters have long used plants as indicators of forest site quality. An initial attempt to use plants and groups of plants as indicators in B.C. was made by Bell (1971). Similarly, Klinka (1977) used one or two species to assist in identifying edatopes of various sites in southwestern British Columbia. More recently, indicative values of species in relation to hygrotope and/or trophotope were proposed on a regional scale by Pojar et al. (1982) and Comeau et al. (1982).

Krajina et al. (1985)[1] have recently completed a treatise on ecological characteristics of about 2750 vascular plants found in the province. Krajina (1984, personal communication) has also described ecological characteristics for selected mosses, liverworts, and lichens commonly found in the region. This information was instrumental in determining indicative values of individual species in relation to hygrotope and trophotope. In this section general background on indicator plant species, the methods used in their integration, and the proposed edatopic indicator species groups (EISG) are presented.

2.4.3 Background

Ecologists consider vegetation as one of the best expressions of the combined influence of all biotic and environmental factors and history of an ecosystem. In consequence, the vegetation (i.e. species presence, abundance and dominance, and vigour) has been used to infer the nature and quality of ecosystems.

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[1] Krajina, V.J., S. Kojima, K. Klinka and E.B. Peterson. 1985. Ecology of vascular plants in British Columbia, Dept. of Botany, University of British Columbia, Vancouver, B.C. (unpublished manuscript).

The ecological conditions (objects of indication) must be defined before plants are used as indicators of these conditions (Victorov et al. 1965). These ecological conditions can then be recognized from species presence, abundance and dominance, and vigour. It is suggested that each plant species has more or less definitive indicative potential in relation to one or more ecosystem characteristics which can be expressed as single or complex gradients. Some species may be effective indicators of certain ecological condition(s) but others may have little or no indicative value. Thus, plant species can be used as indicators of forest site quality over areas as small as a few square cm (microsites) or as large as many square km (biogeoclimatic units). The indicative value of a species depends on the degree of relationship between the species and the condition for which it is used as an indicator.

For the purpose of site diagnosis we have chosen edatope, representing hygrotope and trophotope, as the object of indication. First, hygrotope and trophotope are two of the three elements used to define site quality. Second, for a given climatope (biogeoclimatic unit), edatope has a determining influence on vegetation (cf. Section 2.3). Plants species, in general, are better indicators of complex environmental gradients such as hygrotope and trophotope than single environmental gradients such as slope gradient, elevation, soil texture, and content of organic matter, which are integrated with difficulty. Thus plants are perhaps the best measure of edatope by expressing the resulting interaction of many individual site factors, particularly in situations where compensating effects may cause different combinations of these factors to produce similar edatopes.

The species or species groups that indicate a particular edatope(s) are referred to as edatopic indicator species or edatopic indicator species groups (EISGs). Because the distribution of plants reflects the actual supply of moisture and nutrients to a site, the EISGs are related to actual rather than potential hygrotope and trophotope. The groups include species of different life form, geographic distribution, and tolerance to other than edaphic factors. Therefore, the full complement of species of a group cannot be expected to occur together on any one site. However, sites can be characterized and subsequently identified by a pattern (spectrum) of different group combination, providing the vegetation development is adequate for site diagnosis. This is the principle used for indicator plant analysis in which the combination of groups determined for a particular site is matched with one of those given for a site unit on the edatopic grid (cf. Section 2.5.2).

2.4.4 Methods

The list of potential edatopic indicators for application within the Vancouver Forest Region included over 400 species. They were selected based on the following criteria:

(a) occurrence in both seral and climax forest communities;
(b) potential to indicate a definitive edatope;
(c) wide distribution in the area; and/or
(d) easy identification.

Krajina et al. (1985) and Krajina (1985, personal communication) provided the source of edatopic indicator values for each species. This information was derived from analysis of the distribution and ecological behaviour of the species in relation to edatope by combining the results of ecological studies conducted in B.C. by Krajina and his students (Brooke et al. 1970, Cordes 1972, Klinka 1976, Kojima and Krajina 1975, Krajina 1969, McMinn 1957, Mueller-Dombois 1959, Wali and Krajina 1973) and by the Ecological Program Staff of the B.C. Ministry of Forests. When possible, indicative values were checked against results of studies conducted elsewhere in Europe and North America (Aichinger 1967, Arbeitskreis Standortskartierung 1978, Bakuzis and Kurmis 1978, Dahl 1956, Ellenberg 1974, 1982, Landolt 1977, Minore 1972, Mezera 1957, Pliva and Prusa 1969, Schonar 1952, Tsiganov 1983).

The procedure to form the species groups began with a cluster analysis, using ranges of indicative values for hygrotope and trophotope and an arbitrary scale of species abundance and dominance for the species as variables. This analysis produced a large number of overlapping groups which had similar distribution modes of hygrotope and trophotope. These groups were compared for similarity, differences, and conformity to a definitive edatope at decreasing levels of similarity. The final edatopic indicator species groups were determined after a series of approximations by selecting those groups showing a more or less narrow range of both hygrotope and trophotope, and those species which conformed most closely to the selection criteria above.

2.4.5 Edatopic Indicator Species Groups

We have recognized 18 groups, each indicative of a certain range of hygrotope and trophotope. Nearly all groups are indicative of two or more classes of hygrotope and trophotope except those for extreme edatopes. The groups are referred to by two-digit numbers; the first digit designates the range of trophotopes (e.g., 1 - nutrient-very poor to medium), the second digit designates the range of actual hygrotopes (e.g., 1 - very dry, 2 - very dry to dry, etc.), (Table 9).

It would be incorrect to interpret that (a) all species included in a group have exactly the same indicative value and (b) their ecological distribution pattern is entirely within the edatope defined for a group. Firstly, no two plant species have exactly the same ecological and sociological amplitude; however, some species do have similar indicative values and can be combined into groups. This means that the species forming an edatopic indicator group show only similar ecological behaviour in relation to part or all of the edatopic range of the group.

Secondly, distribution patterns of most species with respect to complex environmental gradients show, in general, a bell-shaped curve of a certain amplitude. To consider the entire amplitude would produce species groups of a considerably wide edatopic range and, in turn, less effective indicative value. Therefore, when forming the edatopic indicator species groups, we excluded the marginal distribution areas. This means that the edatopic conditions indicated by a given group are those reflecting the predominant distribution modes of the included species.

The EISGs are ordered according to the following combination of trophotope classes:

(a) nutrient-very poor to medium;
(b) nutrient-medium; and
(c) nutrient-medium to very rich.

Within these classes the groups are ordered according to hygrotope in the following seven combinations of hygrotope classes, except the nutrient-medium class for which only four combinations were recognized:

(a) very dry;
(b) very dry to dry;
(c) dry to fresh;
(d) dry to moist;
(e) fresh to moist;
(f) moist to wet; and
(g) wet.

Each EISG is described with the following information:

(a) a two-digit numerical code where the first digit refers to the trophotope class and the second digit refers to the hygrotope class as stated above;

(b) the indicated edatope using a combination of the above hygrotope and trophotope classes; and

(c) the species list including Latin name, common name, and life-form.

With some exceptions, nomenclature of vascular plants follows Taylor and MacBryde (1977), mosses and hepatics follow Crum et al. (1973) and lichens follow Hale and Culberson (1970). Deviations from these references as proposed by Krajina et al. (1985) and their synonyms are listed in Table 8.

A synopsis of the first approximation of EISGs for southwestern B.C. is given in Table 9. The synopsis is followed by figures showing distribution of the groups on the edatopic grid to indicate overlaps among the groups in relation to hygrotope, according to trophotope category (Figures 6, 7, and 8). The reader is reminded that similar overlaps exist among the groups in relation to trophotope.

Species lists for each of 18 groups are given in Table 10. The species marked with asterisk (*) are relatively common and easily identifiable. Therefore, they represent a desirable standard which is required for a meaningful plant indicator analysis. We urge all those wishing to use plants for site diagnosis to learn these species.

The alphabetical list of edatopic indicator species is presented in the appendix, which includes Latin name, common name, life-form, and EISG membership number. Although not included in this report, an appendix containing aids for identifying common indicator plants is included in the field version of the guide. This consists of 60 species for which characteristic features, diagrams, and indicator values have been included to aid in their field recognition.

Table 8. List of species which deviate in name from Taylor and MacBryde (1977), Crum *et al*. (1973), and Hale and Culberson (1970).

Nomenclature used in this report	Nomenclature used by Taylor and MacBryde (1977), Crum *et al*. (1973) and Hale and Culberson (1970)
Achillea lanulosa Nutt.	*Achillea millefolium* Linnaeus var. *lanulosa* (Nuttall) Piper *in* Piper & Beattie
Boykinia elata (Nutt.) Greene	*Boykinia occidentalis* Torrey & Gray
Caltha biflora DC.	*Caltha leptosepala* A.P. de Candolle var. *biflora* (A.P. de Candolle) G. Lawson
Circaea pacifica Ascherson & Magnus	*Circaea alpina* Linnaeus subsp. *pacifica* (Ascherson & Magnus) Raven *in* Calder & Taylor
Cladina stellaris (Opiz) Brodo	*Cladina alpestris* (L.) Harm.
Corallorhiza mertensiana Bong.	*Corallorhiza maculata* Rafinesque subsp. *mertensiana* (Bongard) Calder & Taylor
Dryopteris expansa (Presl) Fraser-Jenkins & Jermy	*Dryopteris assimilis* S. Walker
Heracleum lanatum Michx.	*Heracleum sphondylium* Linnaeus subsp. *montanum* (Gaudin) Briquet *in* Schinz & Keller
Hypopithys lanuginosa (Michx.) Nutt.	*Hypopitys monotropa* Crantz
Juniperus sibirica Burgsd.	*Juniperus communis* Linnaeus subsp. *alpina* (Neilreich) Celakovsky
Kindbergia oregana (Sull.) Ochyra	*Stokesiella oregana* (Sull.) Robins
Kindbergia praelonga (Hedw.) Ochyra	*Stokesiella praelonga* (Hedw.) Robins
Listera banksiana Lindl.	*Listera caurina* Piper
Plagiomnium insigne (Mitt.) Kop.	*Mnium insigne* Mitt.
Pogonatum sylvaticum (Menz.) Lindb.	*Pogonatum alpinum* var. *sylvaticum* (Hoppe) Lawt.
Populus trichocarpa Torr. & Gray *ex* Hook.	*Populus balsamifera* Linnaeus subsp. *trichocarpa* (Torrey & Gray *ex* W.J. Hooker) Brayshaw
Rhizomnium glabrescens (Kindb.) Kop.	*Mnium glabrescens* Kindb.
Rhizomnium magnifolium (Horik.) Kop.	*Rhizomnium perssonii* Kop.
Rhizomnium nudum (Britt. & Williams) Kop.	*Mnium nudum* Williams *ex* Britt. & Williams
Sphagnum fallax (Klinggr.) Klinggr.	*Sphagnum recurvum* P.-Beauv.
Spiraea menziesii Hook.	*Spiraea douglasii* W.J. Hooker subsp. *menziesii* W.J. (Hooker) Calder & Taylor
Symphoricarpos hesperius G.N. Jones	*Symphoricarpos mollis* Nuttall *in* Torrey & Gray var. *hesperius* (G.N. Jones) Cronquist *in* Hitchcock *et al*.
Trientalis arctica Fisch. *ex*. Hook.	*Trientalis europaea* Linnaeus subsp. *arctica* (F.E.L. Fisher *ex* W.J. Hooker) Hulten
Valeriana scouleri Rydb.	*Valeriana sitchensis* Bongard subsp. *scouleri* (Rydberg) Piper
Viburnum trilobum Marsh.	*Viburnum opulus* Linnaeus subsp. *trilobum* (Marshall) R.T. Clausen

TABLE 9. Synopsis of edatopic indicator species groups

1. Nutrient-very poor to medium sites

EISG No. 1.1: Very dry, nutrient-very poor to poor sites

EISG No. 1.2: Very dry to dry, nutrient-very poor to medium sites

EISG No. 1.3: Dry to fresh, nutrient-very poor to medium sites

EISG No. 1.4: Dry to moist, nutrient-very poor to medium sites

EISG No. 1.5: Fresh to moist, nutrient-very poor to medium sites

EISG No. 1.6: Moist to wet, nutrient-very poor to medium sites

EISG No. 1.7: Wet, nutrient-very poor to medium sites

2. Nutrient-medium sites:

EISG No. 2.1: Very dry to dry, nutrient-(poor to) medium sites

EISG No. 2.2: Dry to fresh, nutrient-medium sites

EISG No. 2.3: Dry to moist, nutrient-medium sites

EISG No. 2.4: Fresh to moist, nutrient-medium sites

3. Nutrient-medium to very rich sites:

EISG No. 3.1: Very dry, nutrient-medium (to rich) sites

EISG No. 3.2: Very dry to dry, nutrient-medium to very rich sites

EISG No. 3.3: Dry to fresh, nutrient-medium to very rich sites

EISG No. 3.4: Dry to moist, nutrient-medium to very rich sites

EISG No. 3.5: Fresh to moist, nutrient-medium to very rich sites

EISG No. 3.6: Moist to wet, nutrient-medium to very rich sites

EISG No. 3.7: Wet, nutrient-medium to very rich sites

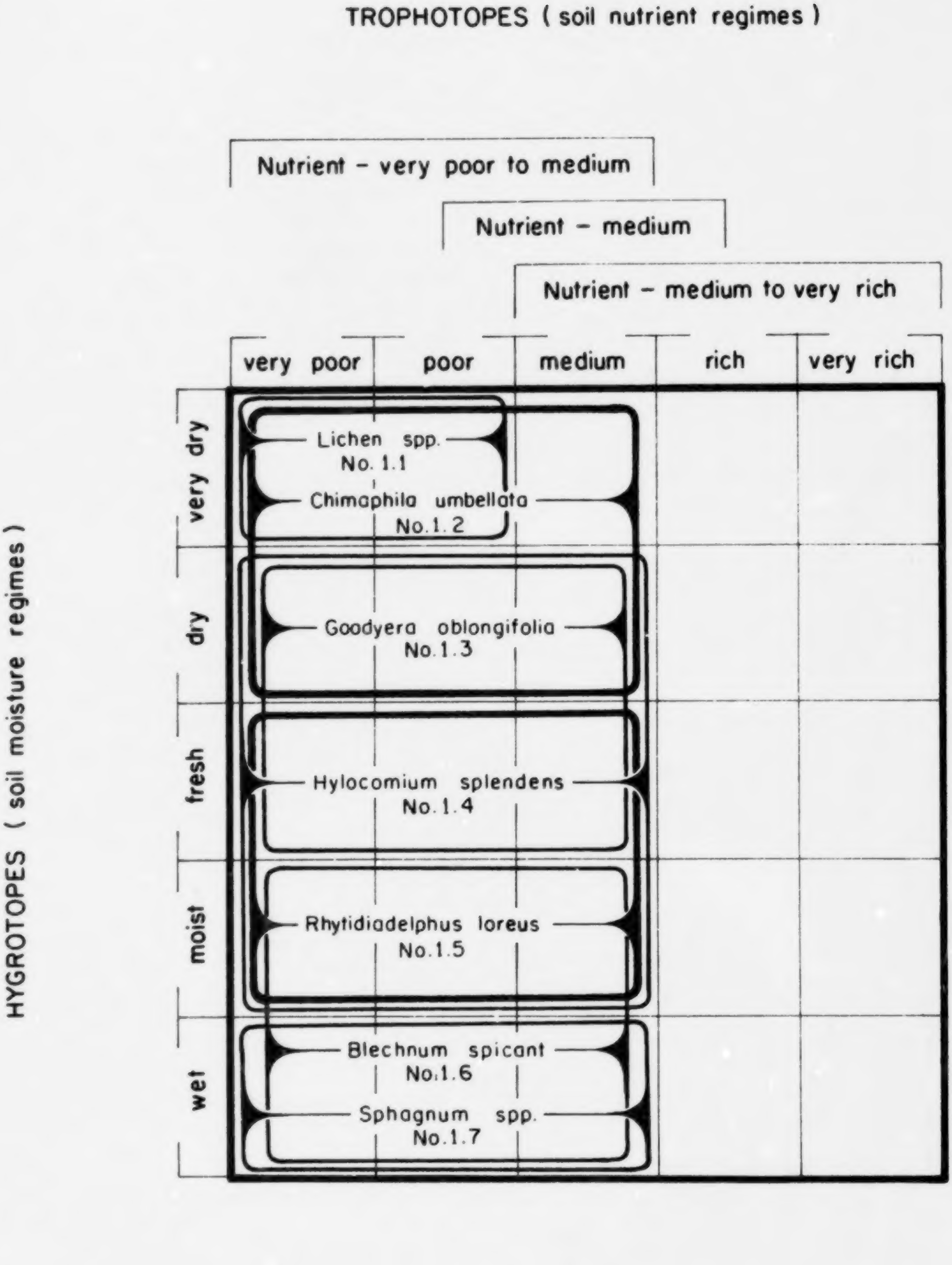

FIGURE 6. A plot of edatopic indicator species groups of nutrient-very poor to medium sites using actual hygrotope and trophotope classes.

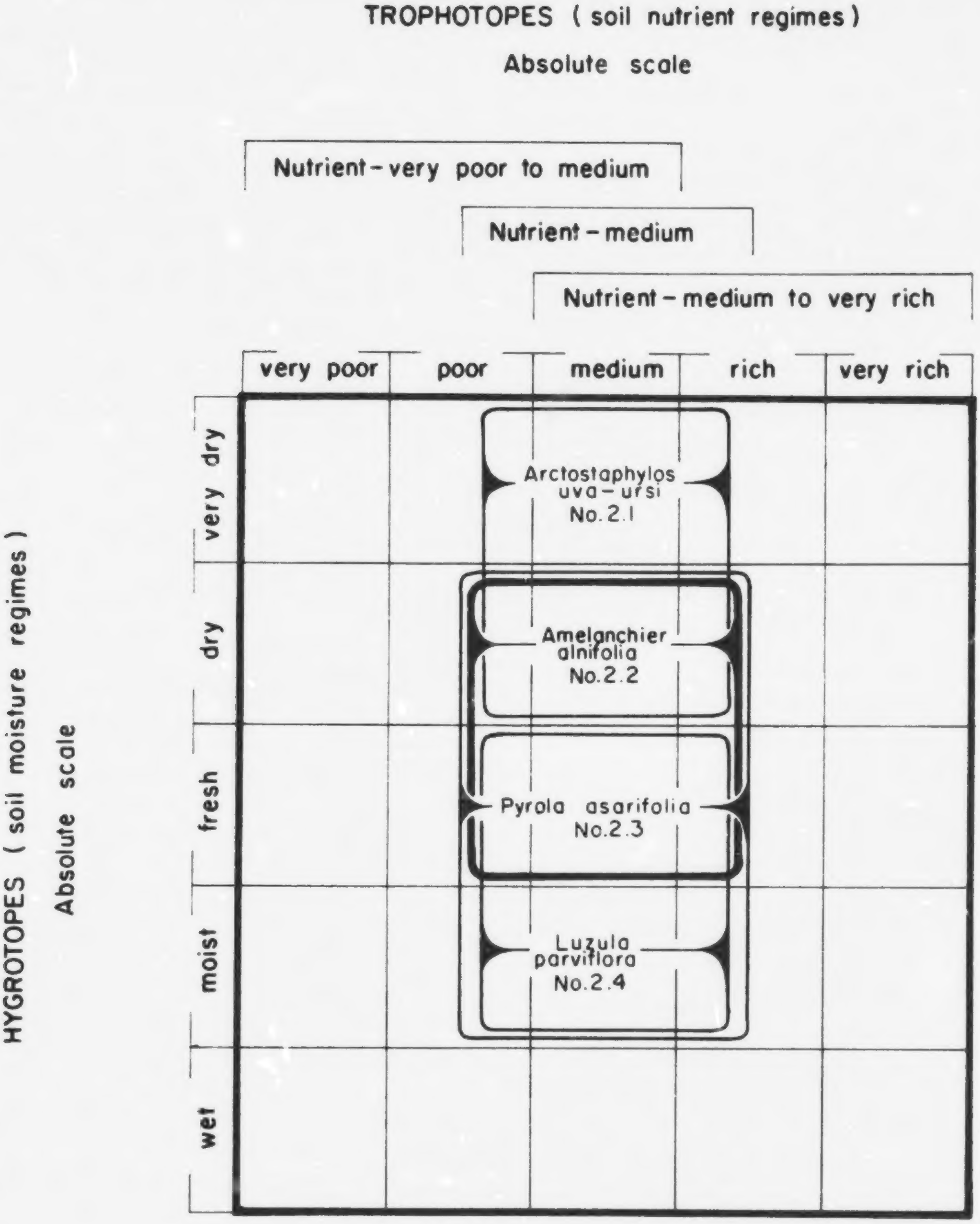
TROPHOTOPES (soil nutrient regimes)
Absolute scale
Nutrient - very poor to medium
Nutrient - medium
Nutrient - medium to very rich
very poor
poor
medium
rich
very rich
HYGROTOPES (soil moisture regimes)
Absolute scale
very dry
dry
fresh
moist
wet
Arctostaphylos uva-ursi No. 2.1
Amelanchier alnifolia No. 2.2
Pyrola asarifolia No. 2.3
Luzula parviflora No. 2.4

FIGURE 7. A plot of edatopic indicator species groups of nutrient-medium sites using actual hygrotope and trophotope classes.

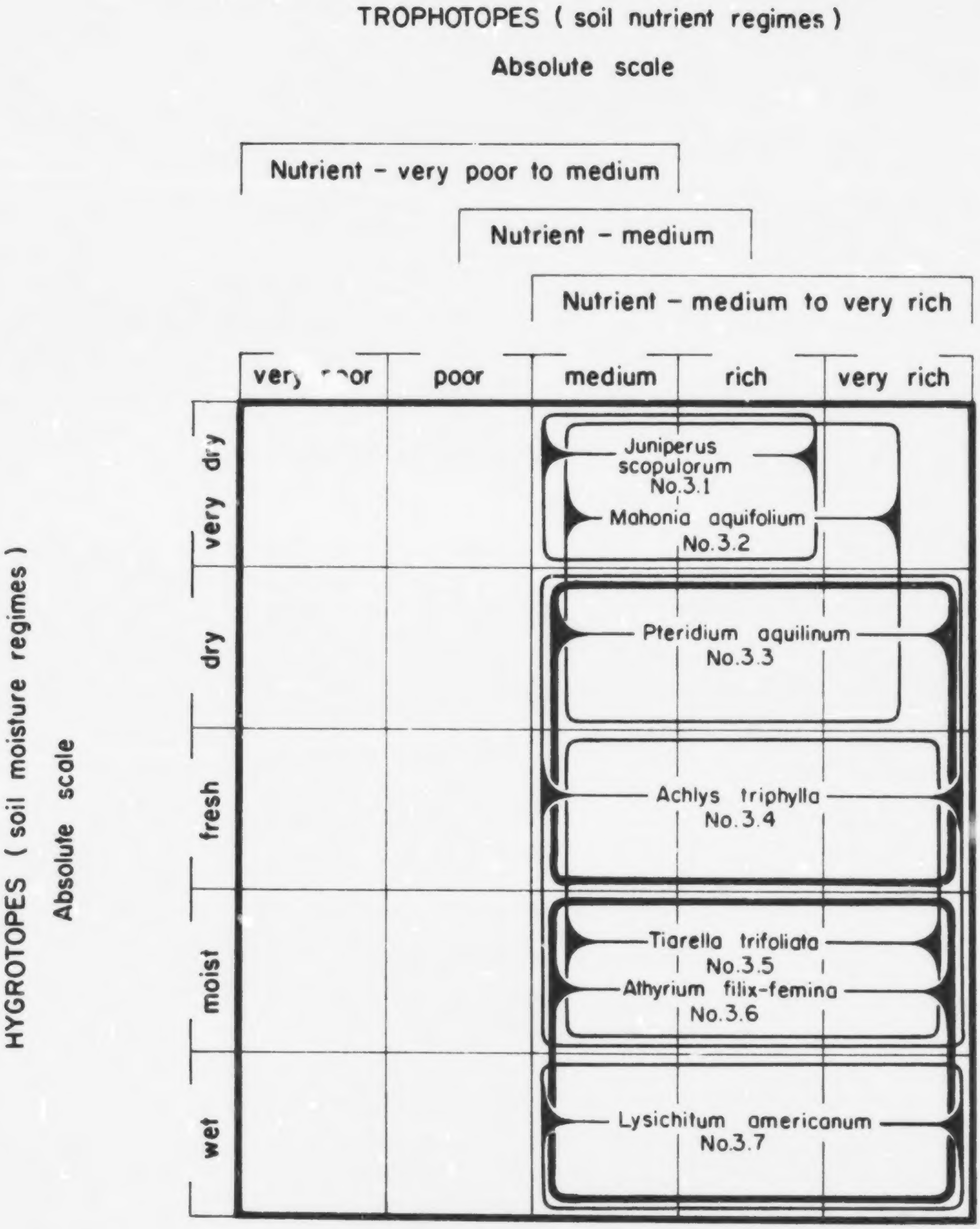
TROPHOTOPES (soil nutrient regimes)
Absolute scale
Nutrient - very poor to medium
Nutrient - medium
Nutrient - medium to very rich
very poor
poor
medium
rich
very rich
HYGROTOPES (soil moisture regimes)
Absolute scale
very dry
dry
fresh
moist
wet
Juniperus scopulorum No.3.1
Mahonia aquifolium No.3.2
Pteridium aquilinum No.3.3
Achlys triphylla No.3.4
Tiarella trifoliata No.3.5
Athyrium filix-femina No.3.6
Lysichitum americanum No.3.7

FIGURE 8. A plot of edatopic indicator species groups of nutrient-medium to very rich sites using actual hygrotope and trophotope classes.

TABLE 10. Edatopic indicator species groups

1. Nutrient-very poor to medium sites

EISG No. 1.1: Very dry, nutrient-very poor to poor sites

Cladina[1] arbuscula	(lchn)[2]
Cladina[1] impexa	(lchn)
Cladina[1] mitis	(lchn)
Cladina[1] rangiferina	(lchn)
Cladina[1] stellaris	(lchn)
Cladonia[1] gracilis	(lchn)
*[3]Rhacomitrium canescens	(moss)
Rhacomitrium heterostichum	(moss)
Stereocaulon[1] tomentosum	(lchn)

EISG No. 1.2: Very dry to dry, nutrient-very poor to medium sites

* Allotropa virgata	candystick	(pasa)
* Arbutus menziesii	arbutus	(brtr)
* Boschniakia hookeri	groundcone	(pasa)
* Chimaphila umbellata	prince's pine	(evsh)
Cladonia bellidiflora	red top lichen	(lchn)
* Cytisus scoparius	broom	(dcsh)
Dicranum fuscescens		(moss)
Dicranum tauricum	broken-leaf moss	(moss)
* Gaultheria ovatifolia	western tea-berry	(evsh)
Homalothecium megaptilum		(moss)
* Peltigera aphthosa		(lchn)

EISG No. 1.3: Dry to fresh, nutrient-very poor to medium sites

Barbilophozia floerkei		(lvrt)
Barbilophozia lycopodioides	common leafy liverwort	(lvrt)
Brachythecium albicans	lawn moss	(moss)
Dicranum howellii		(moss)
Dicranum pallidisetum		(moss)
* Festuca occidentalis	western fescue	(gram)
* Goodyera oblongifolia	rattlesnake-plantain	(herb)
* Hieracium albiflorum	white-flowered hawkweed	(herb)
Hypochoeris radicata	hairy cat's-ear	(herb)
Hypopithys lanuginosa	pinesap	(pasa)
* Lycopodium annotinum	stiff club-moss	(fern)

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[1] May all be referred to as lichen spp.

[2] Legend to life-form codes on page 181.

[3] Species marked with asterisks are a desirable standard for operational use.

TABLE 10. (continued)

EISG No. 1.3: Dry to fresh, nutrient-very poor to medium sites (cont'd)

* Lycopodium clavatum	running club-moss	(fern)
Lycopodium complanatum	ground-cedar	(fern)
* Orthilia secunda	one-sided wintergreen	(herb)
* Paxistima myrsinites	falsebox	(evsh)
* Peltigera membranacea		(lchn)
* Platanthera orbiculata	round-leaved rein-orchid	(herb)
* Pleurozium schreberi	red-stemmed feather moss	(moss)
* Polytrichum juniperinum		(moss)
* Rosa gymnocarpa	baldhip rose	(dcsh)
* Sorbus scopulina	western mountain-ash	(dcsh)
* Sorbus sitchensis	Sitka mountain-ash	(dcsh)
* Vaccinium membranaceum	black huckleberry	(dcsh)
* Vaccinium ovatum	evergreen huckleberry	(evsh)
* Vaccinium parvifolium	red huckleberry	(dcsh)
* Viola orbiculata	round-leaved violet	(herb)

EISG No. 1.4: Dry to moist, nutrient-very poor to medium sites

* Cassiope mertensiana	white mountain-heather	(evsh)
* Chimaphila menziesii	Menzies' pipsissewa	(evsh)
* Clintonia uniflora	queen's cup	(herb)
* Corallorhiza mertensiana	western coralroot	(pasa)
* Cornus canadensis	bunchberry	(herb)
* Empetrum nigrum	crowberry	(evsh)
* Gaultheria shallon	salal	(evsh)
* Hylocomium splendens	stepmoss	(moss)
* Linnaea borealis	twinflower	(evsh)
* Listera cordata	heart-leaved twayblade	(herb)
* Phyllodoce empetriformis	pink mountain-heather	(evsh)
* Ptilium crista-castrensis	knight's plume moss	(moss)
* Rhododendron albiflorum	white-flowered rhododendron	(dcsh)
* Rhytidiopsis robusta	pipecleaner moss	(moss)

EISG No. 1.5: Fresh to moist, nutrient-very poor to medium sites

Calypogeja trichomanis		(lvrt)
* Cassiope stelleriana	Alaskan mountain-heather	(evsh)
* Cladothamnus pyroliflorus	copperbush	(dcsh)
* Cornus unalaschkensis	Cordilleran bunchberry	(herb)
* Dryopteris expansa	spiny wood fern	(fern)
Gaultheria hispidula	creeping-snowberry	(evsh)
Gaultheria humifusa	alpine-wintergreen	(evsh)
Geocaulon lividum	bastard toad-flax	(herb)
Isopterygium elegans		(moss)

TABLE 10. (continued)

EISG No. 1.5: Fresh to moist, nutrient-very poor to medium sites (cont'd)

Lepidozia reptans		(lvrt)
* Menziesia ferruginea	false azalea	(dcsh)
* Plagiothecium undulatum		(moss)
* Rhytidiadelphus loreus		(moss)
* Rubus pedatus	five-leaved bramble	(evsh)
* Streptopus streptopoides	small twistedstalk	(herb)
* Vaccinium alaskaense	Alaskan blueberry	(dcsh)
* Vaccinium caespitosum	dwarf blueberry	(dcsh)
* Vaccinium deliciosum	Cascade blueberry	(dcsh)

EISG No. 1.6: Moist to wet, nutrient-very poor to medium sites

Bazzania tricrenata		(lvrt)
* Blechnum spicant	deer fern	(fern)
* Coptis aspleniifolia	spleenwort-leaved goldthread	(herb)
* Coptis trifolia	three-leaved goldthread	(herb)
* Sanguisorba canadensis	Sitka burnet	(herb)
* Sanguisorba officinalis	great burnet	(herb)
Siphula ceratites		(lchn)
* Spiraea douglasii	hardhack	(dcsh)
Stenanthium occidentale	mountainbells	(herb)
* Vaccinium uliginosum	bog blueberry	(dcsh)
Vahlodea atropurpurea	mountain hair-grass	(gram)

EISG No. 1.7: Wet, nutrient-very poor to medium sites

Andromeda polifolia	bog rosemary	(herb)
* Drosera rotundifolia	round-leaved sundew	(herb)
Eriophorum angustifolium	narrow-leaved cotton-grass	(gram)
Fauria crista-galli	deer cabbage	(herb)
Fontinalis antipyretica		(moss)
Gentiana douglasiana	swamp gentian	(herb)
Gentiana sceptrum	king gentian	(herb)
* Kalmia microphylla	bog-laurel	(evsh)
* Ledum groenlandicum	Labrador tea	(evsh)
Rhynchospora alba	beak-rush	(gram)
Sphagnum[4] fallax		(moss)
Sphagnum[4] fuscum		(moss)
Sphagnum[4] girgensohnii		(moss)

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[4] May all be referred to as Sphagnum spp.

TABLE 10. (continued)

EISG No. 1.7: Wet, nutrient-very poor to medium sites (cont'd)

Sphagnum[4] papillosum		(moss)
Sphagnum[4] tenellum		(moss)
Trichophorum caespitosum	tufted deer-grass	(gram)
Trientalis arctica	northern starflower	(herb)
* Vaccinium oxycoccos	bog cranberry	(evsh)

2. Nutrient-medium sites

EISG No. 2.1: Very dry to dry, nutrient (poor to) medium sites

Aira caryophyllea	silver hairgrass	(gram)
Aira praecox	early hairgrass	(gram)
* Apocynum androsaemifolium	spreading dogbane	(herb)
* Arctostaphylos columbiana	hairy manzanita	(evsh)
* Arctostaphylos uva-ursi	kinnikinnick	(evsh)
Cryptogramma crispa	parsley fern	(fern)
Danthonia californica	California oatgrass	(gram)
Danthonia spicata	poverty oatgrass	(gram)
* Holodiscus discolor	ocean-spray	(dcsh)
* Luzula multiflora	many-flowered woodrush	(gram)
Polytrichum piliferum		(moss)
* Pterospora andromedea	pinedrops	(pasa)
Pyrola dentata	Nootka wintergreen	(herb)
* Vaccinium scoparium	grouseberry	(dcsh)

EISG No. 2.2: Dry to fresh, nutrient-medium sites

* Amelanchier alnifolia	Saskatoon	(dcsh)
* Arnica cordifolia	heart-leaved arnica	(herb)
* Asplenium trichomanes	maidenhair spleenwort	(fern)
Bartramia pomiformis	apple moss	(moss)
* Kindbergia oregana		(moss)
* Lilium columbianum	tiger lily	(herb)
* Mahonia nervosa	dull Oregon-grape	(evsh)
* Pedicularis racemosa	sickletop lousewort	(herb)
* Rubus ursinus	trailing blackberry	(dcsh)
* Viola adunca	early blue violet	(herb)
* Viola sempervirens	trailing yellow violet	(herb)

[4] May all be referred to as Sphagnum spp.

TABLE 10. (continued)

EISG No. 2.3: Dry to moist, nutrient-medium sites

* Calypso bulbosa	fairy-slipper	(herb)
Holcus lanatus	Yorkshire fog	(gram)
Hypericum formosum	western St. John's-wort	(herb)
* Lonicera utahensis	red twinberry	(dcsh)
Mnium spinulosum		(moss)
* Montia parvifolia	small-leaved montia	(herb)
* Pyrola asarifolia	pink wintergreen	(herb)
* Pyrola chlorantha	green wintergreen	(herb)
* Pyrola picta	white-veined wintergreen	(herb)
Salix scouleriana	Scouler's willow	(dcsh)
Spiraea densiflora	subalpine spirea	(dcsh)
* Tiarella unifoliata	one-leaved foamflower	(herb)
* Vaccinium ovalifolium	oval-leaved blueberry	(dcsh)
Vicia americana	American vetch	(herb)

EISG No. 2.4: Fresh to moist, nutrient-medium sites

* Arnica latifolia	mountain arnica	(herb)
* Cassiope tetragona	four-angled mountain-heather	(evsh)
* Circaea alpina	alpine enchanter's-nightshade	(herb)
Hemitomes congestum	gnome-plant	(pasa)
* Listera banksiana	northwestern twayblade	(herb)
* Luetkea pectinata	partridge foot	(herb)
Luzula parviflora	small-flowered woodrush	(gram)
* Moneses uniflora	single delight	(herb)
* Monotropa uniflora	Indian-pipe	(pasa)
* Pedicularis bracteosa	bracted lousewort	(herb)
Plagiochila porelloides		(lvrt)
* Pogonatum contortum		(moss)
Pogonatum sylvaticum		(moss)
* Rhizomnium glabrescens		(moss)

3. Nutrient-medium to very rich sites

EISG No. 3.1: Very dry, nutrient-medium (to rich) sites

* Agropyron spicatum	bluebunch wheatgrass	(gram)
Campanula scouleri	Scouler's hairbell	(herb)
Carex pensylvanica	long-stoloned sedge	(gram)
Eriophyllum lanatum	woolly sunflower	(herb)
* Juniperus scopulorum	Rocky Mountain juniper	(evsh)
* Sedum spathulifolium	broad-leaved stonecrop	(herb)
* Selaginella wallacei	Wallace's selaginella	(fern)

TABLE 10. (continued)

EISG No. 3.2: Very dry to dry, nutrient-medium to very rich sites

Achillea lanulosa	western yarrow	(herb)
Allium acuminatum	Hooker's onion	(herb)
Allium cernuum	nodding onion	(herb)
Bromus carinatus	California brome	(gram)
Camassia leichtlinii	great camas	(herb)
Camassia quamash	common camas	(herb)
Carex rossii	Ross' sedge	(gram)
* Ceanothus sanguineus	redstem ceanothus	(dcsh)
Ceanothus velutinus	snowbush ceanothus	(evsh)
Erythronium oregonum	white fawn lily	(herb)
Juniperus sibirica	common juniper	(evsh)
* Lonicera ciliosa	orange honeysuckle	(dcsh)
* Lonicera hispidula	purple honeysuckle	(dcsh)
Madia madioides	woodland tarweed	(herb)
* Mahonia aquifolium	tall Oregon-grape	(evsh)
* Quercus garryana	Garry oak	(brtr)
* Ribes lobbii	gummy gooseberry	(dcsh)
Sanicula graveolens	Sierra sanicle	(herb)
Satureja douglasii	yerba buena	(evsh)
* Symphoricarpos hesperius	trailing snowberry	(dcsh)
Zygadenus venenosus	death-camas	(herb)

EISG No. 3.3: Dry to fresh, nutrient-medium to very rich sites

* Adenocaulon bicolor	pathfinder	(herb)
Aster ciliolatus	fringed aster	(herb)
* Aster conspicuus	showy aster	(herb)
* Calamagrostis rubescens	pinegrass	(gram)
* Cornus nuttallii	flowering dogwood	(brtr)
Corylus cornuta	hazelnut	(dcsh)
Elymus glaucus	blue wildrye	(gram)
Lathyrus nevadensis	purple peavine	(herb)
* Lupinus arcticus	arctic lupine	(herb)
Moehringia macrophylla	big-leaved sandwort	(herb)
Perideridia gairdneri	yampah	(herb)
* Phyllodoce glanduliflora	yellow mountain-heather	(evsh)
* Polypodium glycyrrhiza	licorice fern	(fern)
* Polystichum lonchitis	mountain holly-fern	(fern)
* Populus tremuloides	trembling aspen	(brtr)
* Pteridium aquilinum	bracken	(fern)
* Rhytidiadelphus triquetrus	electrified cat's tail moss	(moss)
* Ribes sanguineum	red-flowering currant	(dcsh)
Sanicula crassicaulis	western snake-root	(herb)
* Shepherdia canadensis	soopolallie	(dcsh)
Sisyrinchium douglasii	satin-flower	(herb)
* Spiraea betulifolia	birch-leaved spirea	(dcsh)
Timmia austriaca		(moss)
* Trientalis latifolia	broad-leaved starflower	(herb)

TABLE 10. (continued)

EISG No. 3.4: Dry to moist, nutrient-medium to very rich sites

* Acer glabrum	Douglas maple	(dcsh)
* Achlys triphylla	vanilla leaf	(herb)
* Aralia nudicaulis	wild sarsaparilla	(herb)
Collinsia parviflora	small-flowered blue-eyed Mary	(herb)
Cystopteris fragilis	fragile fern	(fern)
* Disporum hookeri	Hooker's fairybells	(herb)
Disporum trachycarpum	rough-fruited fairybells	(herb)
Dodecatheon hendersonii	broad-leaved shootingstar	(herb)
Dodecatheon pulchellum	few-flowered shootingstar	(herb)
Fritillaria lanceolata	chocolate lily	(herb)
Galium aparine	cleavers	(herb)
Lathyrus ochroleucus	creamy peavine	(herb)
* Lupinus nootkatensis	Nootka lupine	(herb)
Melica subulata	Alaska oniongrass	(gram)
* Philadelphus lewisii	mock-orange	(dcsh)
* Polystichum munitum	sword fern	(fern)
Potentilla glandulosa	sticky cinquefoil	(herb)
* Prunus virginiana	choke cherry	(dcsh)
* Ranunculus occidentalis	western buttercup	(herb)
Ribes divaricatum	wild gooseberry	(dcsh)
* Rosa acicularis	prickly rose	(dcsh)
* Rubus idaeus	red raspberry	(dcsh)
* Rubus leucodermis	black raspberry	(dcsh)
* Rubus parviflorus	thimbleberry	(dcsh)
* Sambucus racemosa	red elderberry	(dcsh)
Senecio sylvaticus	wood groundsel	(herb)
Senecio vulgaris	common groundsel	(herb)
* Smilacina racemosa	false Solomon's-seal	(herb)
* Smilacina stellata	star-flowered false Solomon's-seal	(herb)
* Symphoricarpos albus	common snowberry	(dcsh)
* Taxus brevifolia	western yew	(cntr)

EISG No. 3.5: Fresh to moist, nutrient-medium to very rich sites

* Acer circinatum	vine maple	(dcsh)
* Acer macrophyllum	bigleaf maple	(brtr)
* Aquilegia formosa	red columbine	(herb)
* Aruncus dioicus	goat's-beard	(herb)
* Asarum caudatum	wild ginger	(herb)
Atrichum selwynii		(moss)
Bromus vulgaris	Columbia brome	(gram)
Calamagrostis nutkaensis	Pacific reed grass	(gram)
Circaea pacifica	Pacific enchanter's-nightshade	(herb)
* Claytonia sibirica	Siberian miner's-lettuce	(herb)
* Dicentra formosa	bleeding heart	(herb)

TABLE 10. (continued)

EISG No. 3.5: Fresh to moist, nutrient-medium to very rich sites (cont'd)

Disporum smithii	Smith's fairybells	(herb)
Equisetum hyemale	scouring-rush	(fern)
* Erythronium revolutum	pink fawn lily	(herb)
Festuca subulata	bearded fescue	(gram)
Festuca subuliflora	crinkle-awned fescue	(gram)
* Galium triflorum	sweet-scented bedstraw	(herb)
* Geum macrophyllum	large-leaved avens	(herb)
* Gymnocarpium dryopteris	oak fern	(fern)
* Heracleum lanatum	cow-parsnip	(herb)
* Lonicera involucrata	black twinberry	(dcsh)
* Mycelis muralis	milkweed	(herb)
* Oemleria cerasiformis	Indian-plum	(dcsh)
* Osmorhiza chilensis	mountain sweet-cicely	(herb)
Polypodium scouleri	leatherleaf polypody	(fern)
Polystichum braunii	Braun's holly-fern	(fern)
* Populus trichocarpa	black cottonwood	(brtr)
Prenanthes alata	western rattlesnake root	(herb)
* Ribes lacustre	black gooseberry	(dcsh)
Rubus pubescens	trailing raspberry	(evsh)
* Streptopus amplexifolius	clasping twistedstalk	(herb)
* Streptopus roseus	rosy twistedstalk	(herb)
* Tellima grandiflora	tall fringecup	(herb)
* Thalictrum occidentale	western meadowrue	(herb)
* Tiarella laciniata	cut-leaved foamflower	(herb)
* Tiarella trifoliata	three-leaved foamflower	(herb)
* Tolmiea menziesii	piggy-back plant	(herb)
* Trillium ovatum	trillium	(herb)
Trisetum cernuum	nodding trisetum	(gram)
* Urtica dioica	stinging nettle	(herb)

EISG No. 3.6: Moist to wet, nutrient-medium to very rich sites

* Actaea rubra	baneberry	(herb)
* Adiantum pedatum	maidenhair fern	(fern)
* Alnus rubra	red alder	(brtr)
* Athyrium filix-femina	lady fern	(fern)
Boykinia elata	coast boykinia	(herb)
Calamagrostis canadensis	bluejoint	(gram)
Cardamine nuttallii	Nuttall's bitter-cress	(herb)
Carex deweyana	Dewey's sedge	(gram)
Carex hendersonii	Henderson's sedge	(gram)
Cinna latifolia	nodding wood-reed	(gram)
* Conocephalum conicum		(lvrt)
* Cornus sericea	red-osier dogwood	(dcsh)
Crataegus douglasii	black hawthorn	(dcsh)
Diplophyllum albicans		(lvrt)
* Equisetum pratense	meadow horsetail	(fern)
Erigeron peregrinus	subalpine daisy	(herb)

TABLE 10. (continued)

EISG No. 3.6: Moist to wet, nutrient-medium to very rich sites (cont'd)

Hookeria lucens		(moss)
* Kindbergia praelonga		(moss)
* Leucolepis menziesii		(moss)
* Maianthemum dilatatum	false lily-of-the-valley	(herb)
Marchantia polymorpha		(lvrt)
* Mitella breweri	Brewer's mitrewort	(herb)
Mitella nuda		(herb)
* Mitella ovalis	oval-leaved mitrewort	(herb)
* Mitella pentandra	five-stamened mitrewort	(herb)
* Oplopanax horridus	devil's club	(dcsh)
Parnassia fimbriata	fringed grass-of-Parnassus	(herb)
Petasites frigidus	sweet colt's-foot	(herb)
* Petasites palmatus	palmate colt's-foot	(herb)
* Physocarpus capitatus	Pacific ninebark	(dcsh)
* Plagiomnium insigne		(moss)
Ranunculus eschscholzii	subalpine buttercup	(herb)
Ranunculus uncinatus	little buttercup	(herb)
* Rhamnus purshianus	cascara	(dcsh)
Rhizomnium nudum		(moss)
Rhytidiadelphus squarrosus		(moss)
* Ribes bracteosum	stink currant	(dcsh)
* Rubus spectabilis	salmonberry	(dcsh)
Salix hookeriana	Hooker's willow	(dcsh)
Spiraea menziesii	pink spirea	(dcsh)
* Stachys cooleyae	Cooley's hedge-nettle	(herb)
Stachys mexicana	Mexican hedge-nettle	(herb)
Stellaria crispa	crisp starwort	(herb)
* Trautvetteria caroliniensis	false bugbane	(herb)
Valeriana scouleri	Scouler's Sitka valerian	(herb)
* Valeriana sitchensis	Sitka valerian	(herb)
* Veratrum viride	Indian hellabore	(herb)
* Viburnum edule	high bush-cranberry	(dcsh)
Viburnum trilobum	American bush-cranberry	(dcsh)
* Viola glabella	stream violet	(herb)

EISG No. 3.7: Wet, nutrient-medium to very rich sites

Angelica genuflexa	kneeling angelica	(herb)
* Caltha biflora	two-flowered white marsh-marigold	(herb)
* Caltha leptosepala	alpine white marsh-marigold	(herb)
Cardamine breweri	Brewer's bitter-cress	(herb)
Carex aquatilis	water sedge	(gram)
Carex laeviculmis	smooth-stemmed sedge	(gram)
Carex livida	pale sedge	(gram)
Carex obnupta	slough sedge	(gram)
Equisetum sylvaticum	wood horsetail	(fern)

TABLE 10. (continued)

EISG No. 3.7: Wet, nutrient-medium to very rich sites (cont'd)

* Equisetum telmateia	giant horsetail	(fern)
Juncus effusus	common rush	(gram)
Juncus ensifolius	dagger-leaved rush	(gram)
Listera convallarioides	broad-leaved twayblade	(herb)
* Lysichitum americanum	skunk cabbage	(herb)
* Malus fusca	Pacific crab apple	(brtr)
* Myrica gale	sweet gale	(dcsh)
* Oenanthe sarmentosa	Pacific oenanthe	(herb)
Pellia neesiana		(lvrt)
Philonotis fontana		(moss)
* Platanthera dilatata	white bog-orchid	(herb)
Ranunculus repens	creeping buttercup	(herb)
Rhizomnium magnifolium		(moss)
* Scirpus microcarpus	small-flowered bulrush	(gram)
Sphagnum palustre		(moss)
Tofieldia glutinosa	sticky false asphodel	(herb)
Torreyochloa pauciflora	false manna	(gram)
* Veronica americana	American brooklime	(herb)

2.5 Procedure for Site Diagnosis

Site diagnosis involves two major steps: the analysis of environmental properties and the indicator plant analysis. At the final stage, the results of these analyses are integrated then combined with the biogeoclimatic unit to determine site quality. When undertaking site diagnosis it is important to (a) collect the required information and (b) follow a logical sequence to ensure the procedure is carried out accurately and efficiently. For the former, a description form could be used, at least initially, until the user becomes familiar with the required data (Figures 9 and 10). For the latter, Figure 11 shows a sequence of steps which should be followed when conducting site diagnosis. Again, with increasing experience, the users may develop their own process most suitable for the local area.

To diagnose a given site, a representative area of approximately 400 m^2 in size should be used for collection of vegetation and environmental data. As the environmental analysis requires examination of the soil, a soil pit should be dug extending through the rooting zone. A depth of 30 to 60 cm will be sufficient in most situations. Road cuts or root turns may also be used, provided the disturbed face is cut back to expose fresh material.

SITE DIAGNOSIS FORM

REFERENCE :

ENVIRONMENTAL ANALYSIS

General Features

1. Elevation: ________ m 2. Slope gradient: ________ % 3. Aspect: ________ °azimuth

4. Slope position: ________ ridge crest ________ lower slope
________ upper slope ________ flat
________ middle slope ________ depression

5. Slope shape: ________ convex ________ straight ________ concave

Soil Features

6. Soil depth: ________ extremely shallow(<.25m) ________ shallow(.5-1m)
________ very shallow(.25-.5m) ________ deep(>1m)

7. Soil texture: ________ sandy(LS,S) 8. Coarse fragment content: ________ <10%
________ loamy (SL,L,SCL) ________ 10-35%
________ silty (SiL,Si) ________ 35-70%
________ clayey (SiCL,CL,SC,SiC,C) ________ >70%
________ organic

9. Coarse fragment/bedrock lithology:

________ volcanic ________ granitic
________ sedimentary (fine) ________ sedimentary (coarse)
________ metamorphic (fine) ________ metamorphic (coarse)
________ limestone

________ base-low
________ base-medium
________ base-high

10. **Seepage or groundwater table:** ________ no ________ yes ________ depth (cm)

11. Gleyed horizons: ________ no ________ yes ________ depth (cm)

12. Flooding: ________ no ________ yes

13. Soil colour: ________ light ________ medium ________ dark

14. A horizon: ________ Ae ________ Ah ________ thickness(cm)

15. Soil porosity -aeration: ________ low ________ moderate ________ high

16. Humus form:

Thickness: ________ cm
Classification: ________ Mor (matted F horizon, fungal mycelia)
________ Moder (loose F horizon, insects)
________ Mull (very thin litter horizons, A_h present)
- - - - - - - - - - - - - -
________ Hydro-(modifier)

FIGURE 9. Example of data form for site diagnosis - part 1.

INDICATOR PLANT ANALYSIS

17. Species List:

Trees			Shrubs			Herbs			Mosses liverworts & lichens		
Name	EISG[1]	C[2]	Name	EISG	C	Name	EISG	C	Name	EISG	C

[1] EISG - edatopic indicator species group; [2] C - cover class

18. Major indicator species groups		
E.I.S.G #	Cover classes of member species	Sum of cover values

Cover classes	
symbol	% cover
+	<1
1	1- <5
2	5- <25
3	25- <50
4	50- < 75
5	≥ 75

SITE QUALITY

19. Biogeoclimatic unit: ______________

20. Hygrotope: ______________

21. Trophotope: ______________

SITE SENSITIVITY

22. Site sensitivity to fire: ________ very high

________ high

________ medium

________ low

________ very low

FIGURE 10. Example of data form for site diagnosis - part 2.

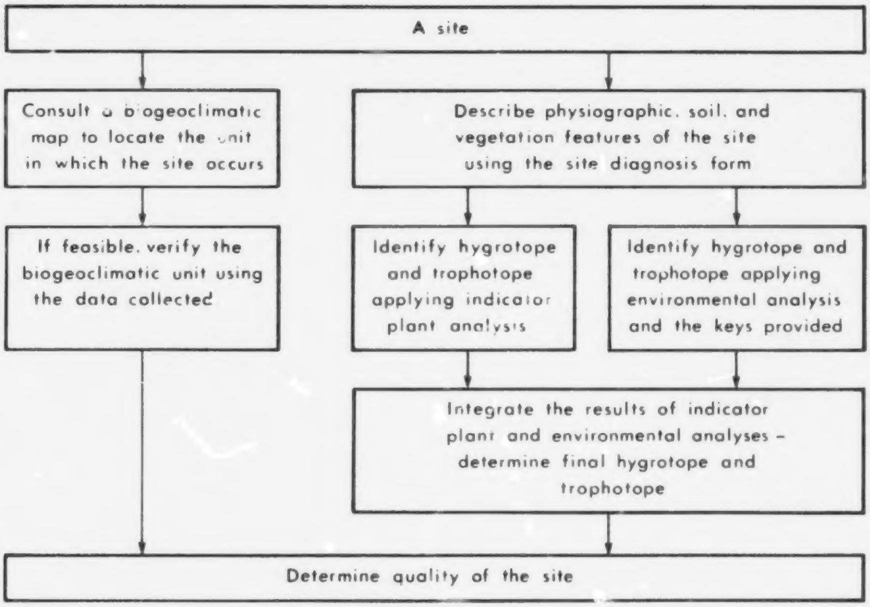

A site
Consult a biogeoclimatic map to locate the unit in which the site occurs
Describe physiographic, soil, and vegetation features of the site using the site diagnosis form
If feasible, verify the biogeoclimatic unit using the data collected
Identify hygrotope and trophotope applying indicator plant analysis
Identify hygrotope and trophotope applying environmental analysis and the keys provided
Integrate the results of indicator plant and environmental analyses – determine final hygrotope and trophotope
Determine quality of the site

FIGURE 11. Flow chart illustrating steps for site diagnosis.

This section describes the environmental analysis, indicator plant analysis, and their integration. General guidelines are given on how to conduct this procedure in conjunction with cutting boundary layout.

2.5.1 Environmental Analysis

The environmental analysis includes evaluation of a number of selected site properties which, in combination, are used to determine site quality.

For the purpose of site diagnosis it was necessary to select site properties which have the greatest influence on hygrotope and trophotope. Furthermore, to make site diagnosis feasible for field staff, it was necessary to restrict the selection to a few physiographic and soil morphological properties that can be accurately and rapidly assessed after moderate training.

The properties found suitable for field application are given in Table 11. They were selected on the basis of their relationships to hygrotope and trophotope established in regional studies (e.g., Brooke et al. 1970, Eis 1962, Kojima and Krajina 1975, Klinka 1976, Lewis 1976, McMinn 1961, Orloci 1964, Roehmer 1972, Sondheim and Klinka 1983) and reported in general reference texts (e.g., Arbeitskreis Standortskartierung 1978, Armson 1977, Buckman and Brady 1969, Buol et al. 1980, Duchafour 1982, Hills 1952, 1960, and 1961, Pritchett 1979, Russell 1973, Tisdale and Nelson 1975, Wilde 1958). These properties were tested for feasibility of field application and, more recently, for their relationships to quantitatively defined hygrotopes and trophotopes.

The following discussion comments briefly on each property and its relationship to hygrotope and trophotope. Understandably, the relationships given are only of a generalized and relative nature, assuming all other properties are constant.

TABLE 11. Site properties selected for environmental analysis

Physiographic properties	Soil properties
elevation[1]	humus form and its thickness
slope aspect	A horizon
slope gradient	soil depth
slope position	organic matter content
slope shape	texture
	content of coarse fragments
	porosity and aeration
	mineralogy
	groundwater table
	gleyed horizons
	incidence of flooding

[1] Used only in the identification of biogeoclimatic units.

2.5.1.1 Physiographic Properties

The selected physiographic properties are elevation, slope aspect, slope gradient, slope position, and slope shape. They are expressions of relief; the elevation or inequalities of the land surface considered collectively (Soil Survey Staff 1951). These properties influence hygrotope and trophotope primarily through modification of climate and water movement in the soil. They can be measured, such as elevation, slope gradient, and slope aspect, or described with discrete categories, such as slope position and slope shape. More specific statements about their relationship to edatope can be made within a particular climatic area.

Aspect

Aspect refers to the direction towards which a slope faces. Variations in aspect primarily influence the distribution of light and heat. Slopes with southerly aspects receive more intense insolation than northerly aspects. As a result, southerly facing slopes are warmer and drier than northerly slopes. The influence of aspect on edatope varies with the climate, latitude, and slope gradient. Aspect may have very little influence in mild (maritime) and humid climates (e.g., in the CWHb and CWHd subzones). Slopes between 60 to 100% gradient generally receive the greatest intensity of insolation on a southerly aspect.

Slope position

Slope position is one of the most influential site properties affecting edatope and, in consequence, the distribution of forest communities on a slope. It is evaluated for the slope segment (meso-slope) which directly affects the water movement in the site. This is defined as the slope between major topographic irregularities (Figure 12). Slope gradient affects lateral water movement downslope. As a result, in humid regions, crests and upper slopes will be drier and nutrient-poorer than lower slopes and depressions which usually receive additional inputs of water and dissolved nutrients from upslope. The additions to, and losses from, middle slopes will be more or less in balance.

The length of the slope, slope gradient, and slope shape decrease or increase the influence of slope position on edatope. Long slopes have large catchment areas and therefore intercept and yield larger volumes of soil water than short slopes. Thus the effective lower slope seepage receiving zone extends higher upslope on long slopes than on short slopes.

The slope gradient determines the velocity of lateral water movement through or over the soil. Therefore, sites on steep upper slopes will be relatively drier and nutrient-poorer than those on moderate or gentle upper slopes.

Slope shape is commonly related to slope position; the upper slopes tend to convex, middle slopes straight, and lower slopes concave. Convex slopes are more strongly drained (tend to shed soil water), while on concave slopes soil water is concentrated.

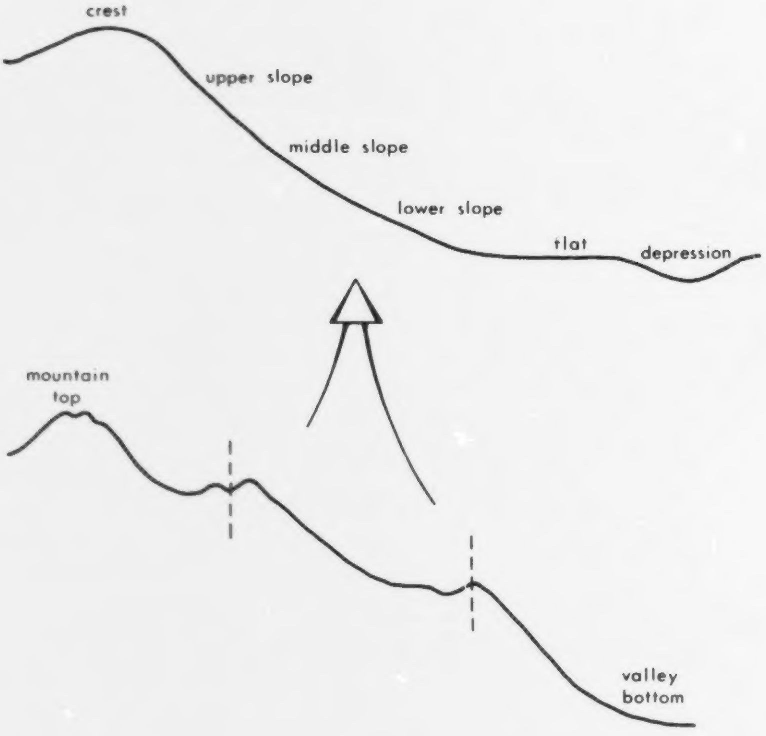


FIGURE 12. The slope segment used to categorize slope position.

2.5.1.2 Soil Properties

The selected soil properties include a number of morphological features that are best evaluated from an examination of the soil profile. All of these features can be readily determined in the field. With experience, one can infer much about the physical, chemical, and biological properties of the soil and make interpretations about the site quality. Some of the selected properties can be measured, such as thickness of forest floor, soil depth, depth of groundwater table, and thickness of the A horizon. Others are described with discrete qualitative categories, such as humus form, A or gleyed soil horizons, content of soil organic matter and coarse fragments, soil porosity, soil mineralogy, and incidence of flooding.

The degree of relationship between these soil properties and edatope may vary depending on the nature of their integrated effect, and through climatic and/or physiographic modifications of edatope. It is also difficult to determine whether some properties have a greater influence on hygrotope or trophotope, because of the intimate relationships between these two elements. Thus, specific statements about these properties and edatope can only be made within a particular climatic and physiographic setting. The selected soil properties are used to make general inferences, recognizing the above limitations, on the soil water and nutrient holding capacity, content of organic matter, nitrogen and bases in the soil, availability of nutrients, degree of decomposition of organic matter, soil aeration, and addition of water and nutrients by groundwater or flooding.

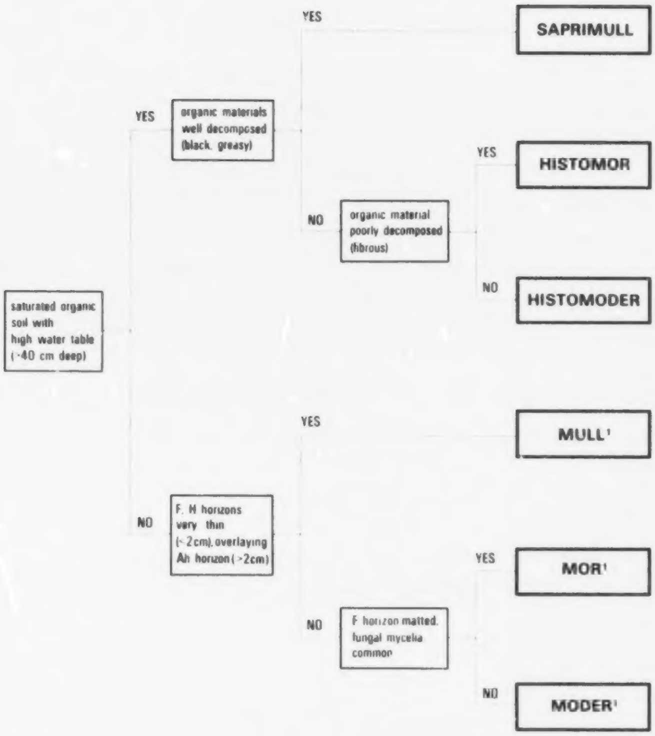
Humus form and its thickness

The humus form refers to the group of horizons located at the soil surface which have formed primarily from organic materials, and which may include mineral soil intermixed with organic material. The organic horizons overlaying mineral soil are commonly referred to as the forest floor or duff and are measured to determine thickness.

The quality of the humus form is an expression of the degree of decomposition and mineralization of soil organic materials. As a result, humus forms have been used as indicators of the intensity of biological nutrient cycling. The decomposition rate is influenced by the physical and chemical properties, temperature, and moisture conditions of the forest floor, which, in turn, determine the kinds and numbers of soil flora and fauna present. Thus, the quality of the humus form can be used for making inferences about the factors controlling decomposition or the results of decomposition, such as acidity, content of bases, and aeration in the uppermost soil layer or the amount of easily available nutrients, particulary nitrogen.

The rate at which organic materials are decomposed is related to one of three basic humus form classes: Mor, Moder, or Mull. In Mors, decomposition is slow, resulting in accumulation of organic materials on the forest floor and relatively low amounts of easily available nutrients. Thus "Mor" sites tend to be nutrient-very poor to medium. This low availability of nutrients, however, can be partially compensated by the effects of mycorrhizae, which increase the capacity of infected plants to absorb water and nutrients. In Mulls, decomposition is rapid resulting in a very thin forest floor and high amounts of easily available nutrients. Thus "Mull" sites tend to be nutrient-rich to very rich. Moders are intermediate in these characteristics. More detailed information on descriptions and classifications of humus forms is given by Klinka et al. (1981). A key to the major humus forms is given in Figure 13.

In relation to hygrotope, organic materials accumulating on the forest floor have a high water holding capacity, the ability to reduce the loss of soil water by evaporation, and the capacity to insulate the soil (which may also affect trophotope). Thus sites with thick "Mor" humus forms are generally wetter and cooler than those associated with thin humus forms.


saturated organic soil with high water table (<40 cm deep)
YES
organic materials well decomposed (black, greasy)
YES
SAPRIMULL
NO
organic material poorly decomposed (fibrous)
YES
HISTOMOR
NO
HISTOMODER
NO
F, H horizons very thin (<2cm), overlaying Ah horizon (>2cm)
YES
MULL¹
NO
F horizon matted, fungal mycelia common
YES
MOR¹
NO
MODER¹

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[1] Prefix with "hydro" if humus form is wet.

FIGURE 13. Key to the identification of general humus form classes.

A horizons

The A horizon is a mineral soil layer formed adjacent to the surface which features either accumulation of humified organic matter or leaching of clay, iron, aluminum and other elements.

The kind of A horizon and its thickness are considered to be expressions of decomposition of organic materials, and content and availability of nutrients in the whole soil since they are closely related to the humus form quality and pedogenic processes of eluviation, or melanization. The melanized Ah horizon signifies an accumulation of organic matter intimately associated with the mineral soil without appreciable translocation and loss of other chemicals, and is the differentiating characteristic of Mull humus forms. The eluviated Ae horizon, signifying loss of nutritionally important organic and mineral materials with the resultant concentration of quartz and other resistant materials, is commonly the underlying horizon of

Mor humus forms. The Ah horizon is darker coloured than underlying soil horizons because of the presence of organic matter, whereas the Ae horizon is lighter coloured than underlying soil horizons because of lower organic matter content and generally coarser texture. Thus, sites with soils featuring Ah horizons will be nutrient-richer whereas those featuring Ae horizons will be nutrient-poorer; this relationship is further emphasized by the thickness of the respective horizons.

Soil depth

Soil depth refers to the effective depth of the soil that is capable of being occupied by tree roots. It varies from a few centimetres to several metres, with the lower limit often being sharply delineated by some restricting layer such as bedrock, compacted (basal) till, or cemented soil horizons. The volume of soil available to tree roots, as dictated by soil depth, affects water and nutrient storage capacity of the soil. Thus, shallow soils will be drier and nutrient-poorer than deep soils.

Soil organic matter content

Soil organic matter originates from detritus falling from forest vegetation. These organic remains undergo the process of humification yielding dark-coloured, amorphous "humus" as an intermediate product. Humus may become incorporated into the mineral soil by the action of organisms, by infiltration, or as a residue of root systems (Wilde 1958).

Upon incorporation with mineral soil, organic matter greatly affects both soil water and nutrient-holding capacities and soil porosity. Also, organic matter is a major source of phosphorus and sulphur, and essentially the sole source of nitrogen. Thus, the amount of organic matter is used as an indicator of reserves of these elements in the soil, particularly of nitrogen, but not necessarily of their availability. Lastly, organic matter is the main source of energy for soil microorganisms - the agents responsible for decomposition and release of these and other essential nutrients from organic materials. Thus, low-organic-matter (light-coloured) soils can be expected to be drier and nutrient-poorer than high-organic-matter (dark-coloured) soils.

Soil colour has been used as an indicator of several important characteristics of soils, among them content of organic matter. Depending on the amount and degree of decomposition, organic matter imparts brown to black colouration to a soil. The content of organic matter associated with the mineral soil is estimated in the field by categorizing the soil colour in three classes: light, medium, and dark. Colour is composed of three measurable variables: hue, value, and chroma. Hue is the dominant spectral colour; value is the measure of degree of darkness or lightness of the colour and is related to the total amount of light reflected; chroma is the measure of the purity of the spectral colour. It is primarily value that reflects the amount of soil organic matter, with low value indicating darker colour and a greater quantity of organic matter. However, colour is not an infallible indicator; it is moisture dependent, especially with respect to colour value, and some soil minerals, such as manganese can also produce dark colours in soils.

Soil texture and content of coarse fragments

Soil texture refers to the relative proportions of the various soil separates less than 2 mm in diameter. Particles larger than 2 mm in diameter are referred to as coarse fragments (gravels, cobbles, or stones). Textural classes are used to identify groupings of soils with similar mixtures of mineral separates. Using a key (Figures 14 and 15), the textural class of a soil can be estimated in the field with reasonable accuracy. Percent volume of the soil occupied by coarse fragments can be estimated in the field.

The size of mineral particles and content of coarse fragments are not easily altered in the soil; therefore, soil texture and coarse fragment content is considered a basic soil property. Soil texture and coarse fragments primarily affect water- and nutrient-holding capacities and porosity of the soil. The capacity of the mineral soil to retain water and nutrients depends largely on the amount of silt and clay. These soil particles are very small and therefore have large surface areas per unit weight, creating a potential for a relatively high capacity to retain water. In addition, clay particles possess a negative surface charge to which cations (e.g., Ca, Mg, Na, K, H) are attracted. Therefore, fine-textured soils, (i.e., those with a high content of silts and clays and low content of coarse fragments) can be expected to be wetter and nutrient richer than coarse-textured soils, other soil properties being constant. On a weight basis, colloidal soil organic matter has greater water- and nutrient-holding capacities than does clay. In consequence, soil organic matter substitutes to some extent for silt and clay in coarse-textured soils.

Soil porosity and aeration

The porosity (pore space) of a soil is that volume of the soil not occupied by solids. The size of pores and pore volume affect water-holding capacity and aeration of the soil. Soils with a high proportion of capillary (small) pores generally have a high water-holding capacity but poor aeration, whereas those with a large proportion of non-capillary (large) pores generally have good aeration but low water-holding capacity.

Soil pores normally contain both air and water, but the relative proportions of each are constantly changing. The percentage of pores occupied

Soil texture is the relative proportion of various "size fractions" of a soil.

Coarse fragments consist of particles greater than 2 mm in diameter. They are estimated visually as a percentage of the whole soil.
% stones + % cobbles + % gravels + % fine fraction = 100% (Total soil)

The **fine fraction** consists of particles less than 2 mm in diameter (for non-spherical particles see accompanying figure). % sand + % silt + % clay = 100% (Fine fraction)

Particles of the two size fractions are defined on the accompanying figure.

The **relative proportion of fine fraction** particles (**sand**, **silt** and **clay**) are estimated through the use of their unique properties of "feel". **Sand** can always be felt as individual **grains**, but silt and clay generally cannot. Dry **silt** feels floury and wet silt is **slippery** or soapy, but not sticky. Dry **clay** forms hard lumps, is very sticky when wet, and plastic (like plasticene) when moist.

Most soils are a mixture of sand, silt and clay, so the graininess, slipperiness or stickiness will vary depending upon how much of each particle size is present. As the amount of clay increases, soil particles bind together better, form stronger casts, and longer, stronger worms. As sand and silt increase the soil binding strength decreases, and only weak to moderately strong casts and worms can be formed. The various classes of soil texture, defined on the **textural triangle** in the accompanying figure, are named by a combination of the dominant particle size, the term "**loam**" meaning a relatively even mix of the three.

The field determination of soil texture is subjective and can only be done consistently with training and experience. The field tests (outlined below and used in sequence with the accompanying flow chart) are provided to assist in the field determination of soil texture.

1) **Graininess Test:** Rub the soil between your fingers. If sand is present, it will feel "grainy". Determine whether sand comprises more or less than 50% of the sample.

2) **Moist Cast Test:** Compress some moist soil by clenching it in your hand. If the soil holds together (i.e. forms a "cast"), then test the durability of the cast by tossing it from hand to hand. The more durable it is, the more clay is present.

3) **Stickiness Test:** Wet the soil thoroughly and compress between thumb and forefinger. Degree of stickiness is determined by noting how strongly the soil adheres to the thumb and forefinger upon the release of pressure, and how much it stretches. Stickiness increases with clay content.

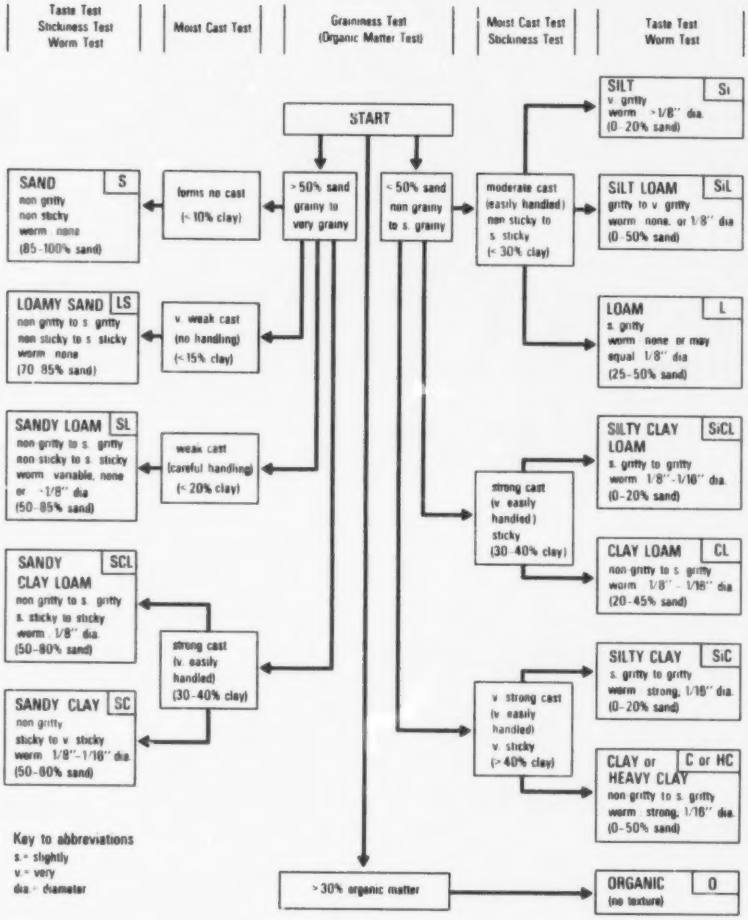
4) **Worm Test:** Roll some moist soil between the palms of your hands to form the longest, thinnest worm possible. The more clay there is in the soil, the longer, thinner and more durable the worm will be.

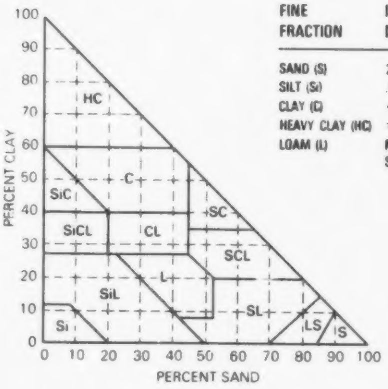
5) **Taste Test:** Work a small amount of soil between your front teeth. Silt particles are distinguished as fine "grittiness", unlike sand which is distinguished as individual grains (i.e. graininess). Clay has absolutely no grittiness at all.

Well decomposed **organic matter** (humus) imparts silt-like properties to the soil. It feels floury when dry and slippery when moist, but **not** sticky and **not** plastic. However, when subjected to the taste test, it feels non-gritty. It is generally very dark when moist or wet, and stains the hands brown or black. Humus-enriched soils often occur on wet sites in association with a heavy moss cover, and on grasslands. Humus is **not** used as a determinant of soil texture; estimate of the silt content of any humus-enriched mineral soil should be reduced accordingly.

"Organic" soil samples are those that contain more than 30% organic matter. Soil texture is **not** determined on organic samples. Most organic soils and deep organic horizons are found on wet sites, often in depressions or on floodplains, also in association with a dense moss cover (frequently *Sphagnum* spp).

FIGURE 14. Key to the field identification of soil texture - part 1. (From B.C. Ministry of Forests, information leaflet FS 238).


Taste Test
Stickiness Test
Worm Test
Moist Cast Test
Graininess Test
(Organic Matter Test)
Moist Cast Test
Stickiness Test
Taste Test
Worm Test
START
> 50% sand grainy to very grainy
< 50% sand non grainy to s. grainy
forms no cast (< 10% clay)
SAND S non gritty non sticky worm : none (85-100% sand)
v. weak cast (no handling) (< 15% clay)
LOAMY SAND LS non gritty to s. gritty non sticky to s. sticky worm : none (70-85% sand)
weak cast (careful handling) (< 20% clay)
SANDY LOAM SL non gritty to s. gritty non sticky to s. sticky worm : variable, none or < 1/8'' dia (50-85% sand)
strong cast (v. easily handled) (30-40% clay)
SANDY CLAY LOAM SCL non gritty to s. gritty s. sticky to sticky worm : 1/8'' dia. (50-80% sand)
SANDY CLAY SC non gritty sticky to v. sticky worm : 1/8''-1/16'' dia. (50-80% sand)
moderate cast (easily handled) non sticky to s. sticky (< 30% clay)
SILT Si v. gritty worm : >1/8'' dia. (0-20% sand)
SILT LOAM SiL gritty to v. gritty worm : none, or 1/8'' dia (0-50% sand)
LOAM L s. gritty worm : none or may equal 1/8'' dia (25-50% sand)
strong cast (v. easily handled) sticky (30-40% clay)
SILTY CLAY LOAM SiCL s. gritty to gritty worm : 1/8''-1/16'' dia. (0-20% sand)
CLAY LOAM CL non gritty to s. gritty worm : 1/8'' - 1/16'' dia. (20-45% sand)
v. strong cast (v. easily handled) v. sticky (> 40% clay)
SILTY CLAY SiC s. gritty to gritty worm : strong, 1/16'' dia. (0-20% sand)
CLAY or HEAVY CLAY C or HC non gritty to s. gritty worm : strong, 1/16'' dia. (0-50% sand)
> 30% organic matter
ORGANIC O (no texture)
Key to abbreviations
s. = slightly
v. = very
dia. = diameter

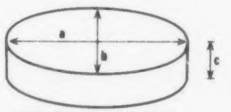


FINE FRACTION	PARTICLE DIAMETER
SAND (S)	2-.05mm
SILT (Si)	.05-.002mm
CLAY (C)	<.002mm
HEAVY CLAY (HC)	>60% CLAY
LOAM (L)	MIX OF SAND, SILT & CLAY

COARSE FRAGMENTS	PARTICLE DIAMETER
STONES	>250mm
COBBLES	250-75mm
GRAVELS	75-2mm

PRINCIPAL AXES OF A COARSE FRAGMENT

a > b > c



coarse fragment size is always determined along the b-axis

FIGURE 15. Key to the field identification of soil texture - part 2.

by air is referred to as soil aeration. Soil aeration informs us about the exchange of air in the soil with atmospheric air, assuming that there is a potential for the ready movement of gases into and out of the pore spaces. In general, soil aeration affects absorption of water, oxygen, and nutrients by plant roots. Soil air is important primarily as a source of oxygen to aerobic organisms, particularly for tree roots and soil microorganisms. Thus, good aeration favours root development and penetration, and hence, results in more intense exploitation of the soil for water and nutrients. It also favours decomposing microorganism activity which, in turn, may increase the supply of available nutrients.

Soil porosity and aeration is evaluated from a combination of the following soil properties: observable pores, colour, structure, and bulk density. Large diameter pores, such as old root channels, are visually estimated. Reddish colours due to ferric (oxidized) compounds are associated with well-aerated soil, while yellowish colours signify intermediate aeration. Ferrous (reduced) compounds of blue and olive colours indicate poorly-aerated soils, while mottling usually indicates a zone of seasonally good and poor aeration. Soil structure to a great extent determines the bulk density (mass of soil per unit volume) of a soil. As a rule, the higher bulk density, the more compact the soil, the more poorly defined the structure, and the smaller the amount of pore space.

Soil mineralogy

Soil mineralogy refers to the chemical composition of the soil. It is inferred from the rock type(s) of coarse fragments comprising the soil and/or the underlying bedrock in the general area. The qualitative classes recognized can be used as indicators of acidity and, in general, nutrient level of the soil.

Soil quality is, to a large degree, determined by the type of parent material, more specifically by its mineralogical composition. In general, the younger the soil, the more influence the parent material has on its quality. As weathering and other processes of soil formation proceed, the influence of the initial materials is diminished. Also, the relationship between soil and its parent material is most obvious in areas where the soils have developed *in situ*, i.e. directly from the underlying bedrock. Soils in the Vancouver Region are relatively young and, for the most part, have developed from pre-weathered unconsolidated glacial materials. Thus, the nature of the initial material will likely have persisting influence on soil texture, mineralogy, and weathering products (as glacial materials tend to reflect the mineralogy of the rocks over which the glaciers passed).

For example, sandstone or granite parent material will generally yield coarse-textured, quartzose, acidic, base-poor soils with low mineral nutrient reserves. In contrast, limestones or calcareous shale parent material will generally yield medium- to fine-textured, base-rich soils with high pH and mineral nutrient reserves. The former is commonly associated with nutrient-very poor to medium soils, while the latter is commonly associated with nutrient-rich to very rich soils.

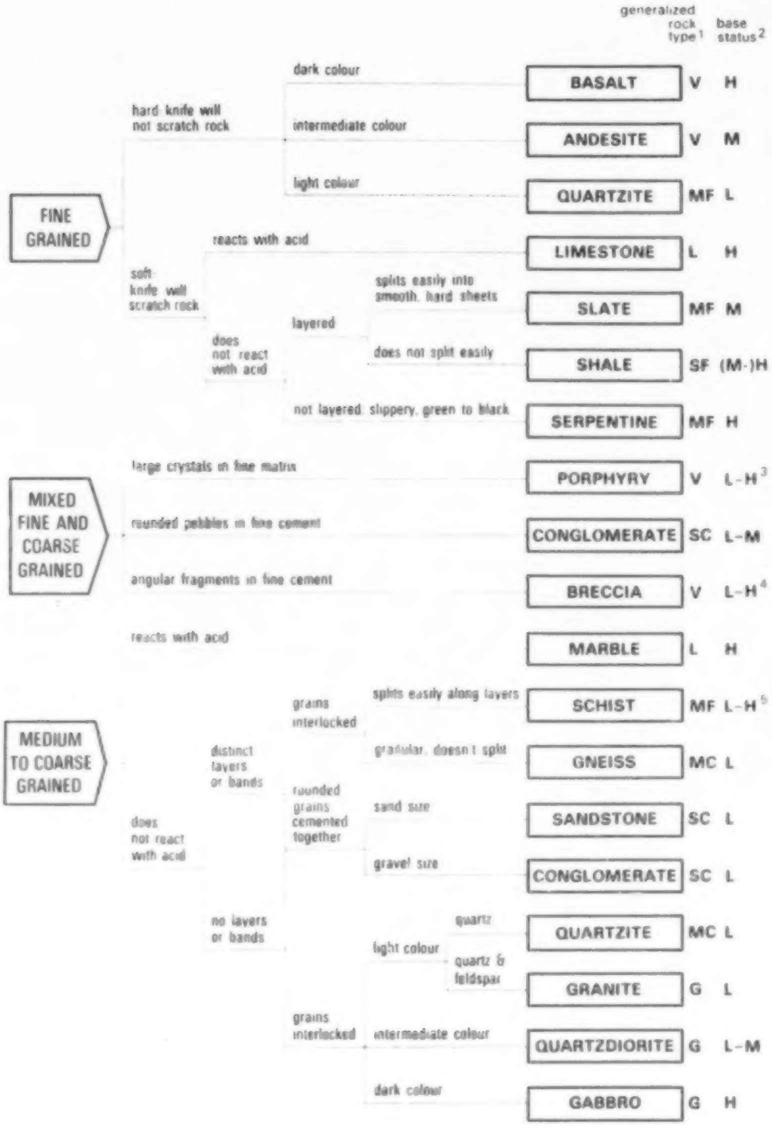
Common rock types can be distinguished and categorized into three classes; base-low, base-medium, and base-high, using the key shown in Figure 16.

Groundwater and incidence of flooding

Depending on climate, slope position, and season, the soil may feature a groundwater table. The water table is defined as the upper surface of groundwater in the soil. It may be permanent, temporary (seasonal) or fluctuating in response to inputs from upslope and precipitation. Groundwater is measured directly by the depth of the water table or inferred from the presence of gleyed horizons in the soil. Gleyed horizons are expressions of gleization, i.e., reduction of iron under anaerobic 'waterlogged' conditions. They are recognized by bluish to greenish-gray matrix colours with or without reddish coloured mottles. However, moving, high-pH and/or well-oxidized groundwater will not develop the gray colours because the iron is maintained in a ferric form, despite saturation with water.

Groundwater represents an additional input of water to the soil, thus it has a direct influence on hygrotope; however, its influence on trophotope will depend on whether the groundwater is stagnant or moving. Stagnant groundwater will have an adverse influence on nutrient availability and uptake. It reduces the effective rooting depth, limits the oxygen supply for roots and aerobic microorganisms, and increases the specific heat of the soil (the soil tends to be colder than surrounding non-saturated soils). In contrast, laterally moving groundwater (seepage) will have a favourable influence on nutrient content, availability, and uptake, usually to the extent of overriding the influence of several other properties related to trophotope. Because the moving groundwater carries solutes and suspended materials, it represents either a temporary or constant additional input of nutrients such as nitrogen, sulphur, calcium, and magnesium.

As a result, soils affected by permanent stagnant groundwater will likely be moist to wet and nutrient-very poor to medium, while those affected by permanent, moving groundwater will likely be also moist to wet but nutrient-medium to very rich. This also depends to some extent on the depth of water table, quantity of water flow, and concentrations of dissolved nutrients.



[1] V – volcanic, L – limestone, SC – sedimentary, coarse, SF – sedimentary, fine, MF – metamorphic, fine – medium, MC – metamorphic, coarse, G – granitic.

[2] L – low, M – medium, H – high (from Hills 1955, Wilde 1958, Walmsley *et al.* 1980)

[3] depends on composition of matrix

[4] depends on component rock

[5] depends on mineral composition

FIGURE 16. Key to the identification of rocks (modified from B.C. Department of Mines and Petroleum Resources, 1970).

Periodic flooding exerts a similar influence on hygrotope and trophotope as seepage depending on the frequency and intensity of flooding and the proximity of the site to the stream. At its peak, floodwater may form a water table above the ground surface, which subsequently subsides and deposits materials carried in suspension. It then moves through the soil at a speed and level corresponding to the stream. Thus, regularly flooded, downstream sites featuring deposits of rich, fine organic and mineral materials will likely be moist to wet and nutrient-rich to very rich. In contrast, occasionally flooded, upstream sites, featuring deposits of poor, mainly coarse mineral materials will generally be dry to fresh and nutrient poor to medium.

2.5.2 Indicator Plant Analysis

Vegetation data collected for site diagnosis are subjected to a field-based indicator plant analysis (Figure 17). Indicator plant analysis can be conducted on all sites with reasonably well developed understory vegetation. Under certain conditions, however, the analysis will not be possible or, if carried out, will produce indefinite results. The analysis should not be conducted, for example, on recently disturbed sites featuring early seral vegetation (e.g., a fireweed community) or in dense, early immature coniferous stands featuring a sparse and discontinuous cover of shade-tolerant mosses and liverworts.

Vegetation data is collected on a sample plot of approximately 400 m^2 in size, selected as representative for a site. All plants species present within the sample plot should be listed except those growing on above-ground substrates such as decaying logs or exposed rock. Commonly occurring plants which cannot be identified in the field should be collected for later identification.

An estimate of percent cover should be recorded for each species in the plot. Percent cover refers to the proportion of the ground area covered by a vertical projection of the crown/foliage onto the ground surface. Table 12 presents the recommended six-class cover scale. Comparison charts to assist in estimating percent cover are given in Figure 18.

Beside each species name the number of the EISG of which it is a member is recorded, consulting the appendix. Then the sum of cover values of all species which are members of the same group is calculated. The total of these cover values gives the "importance rating" for each group. Groups with an importance rating less than three are considered not significant and are not used in the subsequent analysis. The remaining groups are those to be compared with the combinations of groups displayed on the edatopic grids. In situations where only one or two groups or even no

TABLE 12. Cover scale recommended for indicator plant analysis

Symbol	Percent cover
+	< 1
1	1 - 5
2	5 - 25
3	25 - 50
4	50 - 75
5	> 75

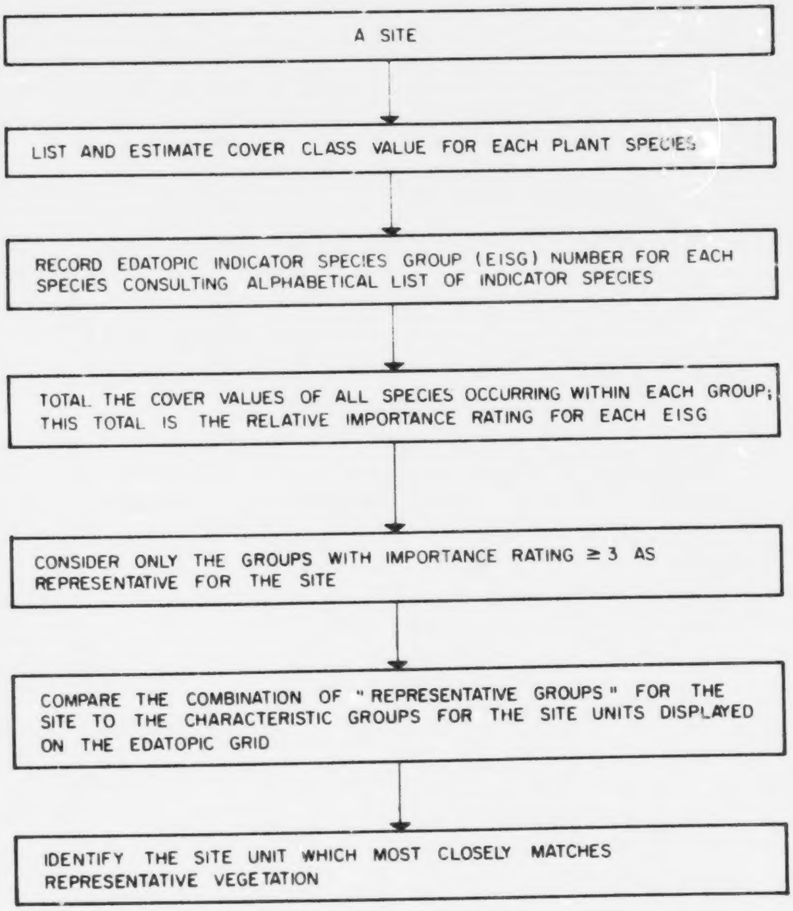

A SITE
LIST AND ESTIMATE COVER CLASS VALUE FOR EACH PLANT SPECIES
RECORD EDATOPIC INDICATOR SPECIES GROUP (EISG) NUMBER FOR EACH SPECIES CONSULTING ALPHABETICAL LIST OF INDICATOR SPECIES
TOTAL THE COVER VALUES OF ALL SPECIES OCCURRING WITHIN EACH GROUP; THIS TOTAL IS THE RELATIVE IMPORTANCE RATING FOR EACH EISG
CONSIDER ONLY THE GROUPS WITH IMPORTANCE RATING ≥ 3 AS REPRESENTATIVE FOR THE SITE
COMPARE THE COMBINATION OF "REPRESENTATIVE GROUPS" FOR THE SITE TO THE CHARACTERISTIC GROUPS FOR THE SITE UNITS DISPLAYED ON THE EDATOPIC GRID
IDENTIFY THE SITE UNIT WHICH MOST CLOSELY MATCHES REPRESENTATIVE VEGETATION

FIGURE 17. Flowchart illustrating steps for indicator plant analysis.

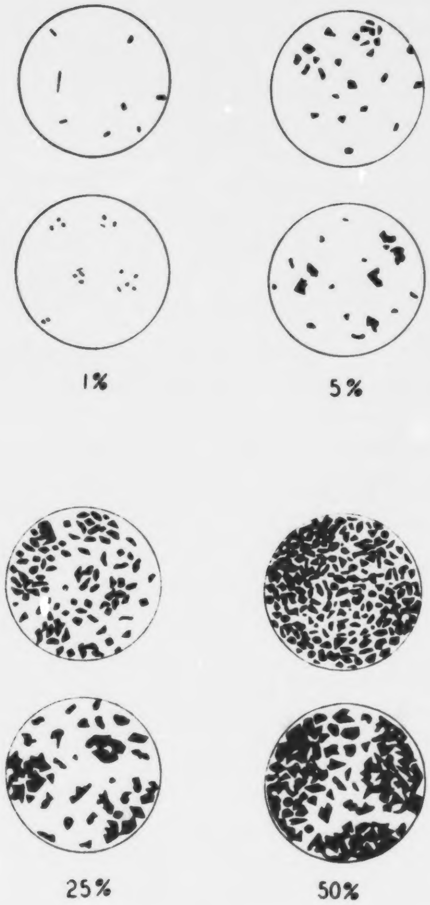


FIGURE 18. Comparison charts for visual estimation of foliage cover (from Walmsley _et al_. 1980).

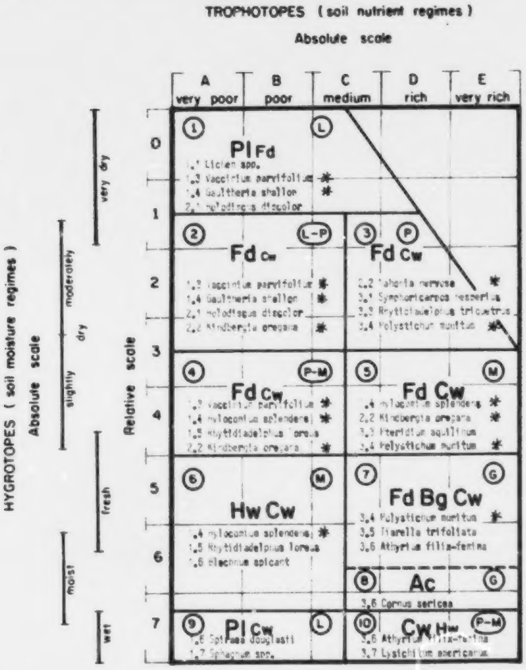
group obtains the above rating limit, the four most important groups (i.e., those with relatively highest rating) may be used; however, this indicates the interpretation of the analysis should be made with caution.

The comparison procedure begins by circling the occurrence of each of the site's representative groups on the edatopic grid for the appropriate biogeoclimatic unit. The site unit with the greatest proportion of its characteristic groups circled can be considered most closely representing the site, pending integration with the environmental analysis. Figure 19 shows an example of indicator plant analysis where the result clearly identifies site unit 7, with all of its characteristic groups being circled.

Grid No. 7

Recommended tree species for the:

CWHa1	VANCOUVER ISLAND DRIER MARITIME CWH VARIANT



PLANT INDICATOR ANALYSIS

17. Species List:

Trees			Shrubs			Herbs			Mosses liverworts & lichens		
Name	EISG[1]	C[2]	Name	EISG	C	Name	EISG	C	Name	EISG	C
Fd	NA	5	Gaul. shallon	1.4	1	Stachys cool.	3.6	1	Leucolepis men	3.6	1
Hw	NA	2	Vacc. parvifol.	1.3	2	Achlys tri.	3.4	3	Rhytidiad. trigu	3.3	2
Bg	NA	3				Tiarella lac.	3.5	1	Plagiomnium ins	3.6	3
						Tiarella tri.	3.5	3			
						Athyrium f.-f.	3.6	1			
						Galium tri.	3.5	2			
						Mycelis mur.	3.5	1			
						Trillium ovat.	3.5	1			
						Polystichum m.	3.4	5			
						Pteridium aqu.	3.3	1			

[1] EISG - edatopic indicator species group; [2] C - cover class

18. Major indicator species groups

E.I.S.G #	Cover classes of member species	Sum of cover values
1.4	1	1
1.3	2	2
3.6	1, 1, 1, 3	6
3.4	3, 5	8
3.5	1, 3, 2, 1, 1	8
3.3	1, 2	3

Cover classes	
symbol	% cover
+	<1
1	1- <5
2	5- <25
3	25- <50
4	50- <75
5	≥ 75

FIGURE 19. Indicator plant analysis for a CWHa1:fresh to moist/nutrient-medium to very rich site.

In some cases, the result is less definite. Figure 20 shows an indicator plant analysis where three site units (2, 4, and 5) have the same proportion of characteristic groups circled. In such cases, the next step would be to compare the representative species for the circled characteristic groups with the species in the vegetation list. Look for characteristic groups which occur more than once on the grid, with different representative species indicated in each case. In this example, the most common species in EISG #1.4 is Hylocomium splendens rather than Gaultheria shallon, thus pointing more to site unit 4 than site unit 2. The analysis, however, remains indefinite with regards to trophotope. Emphasis on environmental analysis is required to complete the diagnosis, suggesting either a considerable in-site variation or a nutrient-medium trophotope.

2.5.3 Synthesizing Results of Environmental Analysis and Integration with Indicator Plant Analysis

When determining site quality it is important to keep in mind that any forest community is an example of the interaction between plants, animals, and microorganisms and their environment. The total environment of a forest community is a complex integration of numerous fluctuating and interacting physical and biological factors. The integated effect of these factors will determine the nature and characteristics of forest communities.

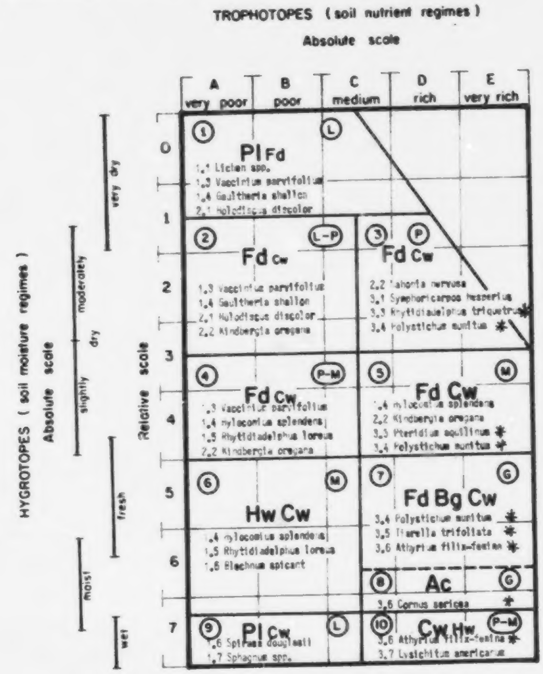
To evaluate site quality we infer climatope, hygrotope, and trophotope of the site, based on the knowledge of their general relationships to - and compensating effects between - easily measured physiographic and soil properties. When inferring hygrotope and trophotope, the interpretation of the integrated effect of individual site properties is often difficult. An understanding of the effects of individual properties on hygrotope and trophotope, and more importantly, how they can compensate each other in providing the same or similar effect is required. To illustrate this, consider a site with a coarse-textured, base-low soil featuring a high content of coarse fragments. These properties alone would suggest an acidic soil with low water and nutrient-holding capacities and nutrient reserves. However, if the site is located at the bottom of a long slope, with the soil affected by permanent seepage and featuring a Moder humus form, then these properties compensate for the effect of the above factors resulting in a moist and nutrient-rich edatope.

To help account for these compensating effects in the assessment of edatope, we have developed keys to the identification of hygrotope and trophotope (Table 13, Figure 21, Table 14, and Figure 22) and have used the indicator plant analysis to verify and, if necessary, amend the inferences made in the environmental analysis. In addition to the key to trophotope, Figure 23 shows schematically, the general relationships between site properties and trophotope.

Grid No. 7

Recommended tree species for the:

CWHa1	VANCOUVER ISLAND DRIER MARITIME CWH VARIANT



INDICATOR PLANT ANALYSIS

17. Species List:

Trees			Shrubs			Herbs			Mosses liverworts & lichens		
Name	EISG[1]	C[2]	Name	EISG	C	Name	EISG	C	Name	EISG	C
Fd	NA	4	Vacc parvifol	1.3	3	Trientalis lat	3.3	+	Plagioth undul	1.2	1
Hw	NA	2	Mahonia nerv	2.2	2	Listera cord	1.4	+	Kindberg oreg	2.2	3
Bg	NA	2	Gaulthera sh	1.4	2	Polystichum m	3.4	1	Hylocom splend	1.4	3
						Achlys tri	3.4	2	Rhytidiad lor	1.5	1
						Mycelis mur	3.5	+	Rhytidiad trigu	3.3	1
						Pteridium aqu	3.3	1			
						Linnaea bor	1.4	2			
						Tiarella tri	3.5	+			

[1] EISG - edatopic indicator species group; [2] C - cover class

18. Major indicator species groups

E.I.S.G #	Cover classes of member species	Sum of cover values
1.3	3	3
2.2	2, 3	5
1.4	2, +, 2, 3	7.5
3.3	+, 1	1.5
3.4	1, 2	3
3.5	+, +,	1

Cover classes	
symbol	% cover
+	<1
1	1- <5
2	5- <25
3	25- <50
4	50- <75
5	≥75

FIGURE 20. Indicator plant analysis for a CWHa1: slightly dry/nutrient medium site.

TABLE 13. Key to the identification of potential hygrotopes - part 1

This key was devised to aid field staff in the Vancouver Forest Region in the identification of hygrotope using readily observable environmental features. It should be applied with caution on ridge crests, upper slopes, and middle slopes which have soils characterized by thick (> 20cm) accumulations of organic materials. In such cases, the potential hygrotope will generally be higher than indicated.

Category	Definition
Ridge crest	height of land; usually convex slope shape.
Upper slope	the generally convex shaped, upper (shedding) portion of a slope.
Middle slope	the portion of a hill between the upper and lower slopes; the slope shape is usually straight.
Lower slope	the area towards the base of a slope (receiving); the slope shape is usually concave. It includes toe slopes which are generally level areas located directly below and adjacent to the lower slope.
Flat	any level area (excluding toe slopes); the surface shape is generally horizontal with no significant aspect.
Alluvium	post-glacial, active floodplain deposits along rivers and streams in valley bottoms; usually a series of low benches and channels.
Depression	any area that is concave in all directions; usually at the foot of a slope or in flat topography.
Soil depth	depth from the mineral soil surface to a restricting layer such as bedrock, strongly compacted, or strongly cemented materials (e.g. "hardpan").
Gleyed	soils that have orange coloured mottles indicative of a fluctuating water table. Permanently gleyed soils are dull yellowish, blue, or olive in colour.
Soil particle size coarse	sandy[1] with >35% volume of coarse fragments or loamy[1] with >70% volume of coarse fragments.
Fine texture	silty[1] or clayey[1] with low coarse fragment volume.

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[1] Sandy - LS,S;, loamy - SL,L,SCL; clayey - SiCL,CL,SC,SiC,C; silty - SiL,Si.

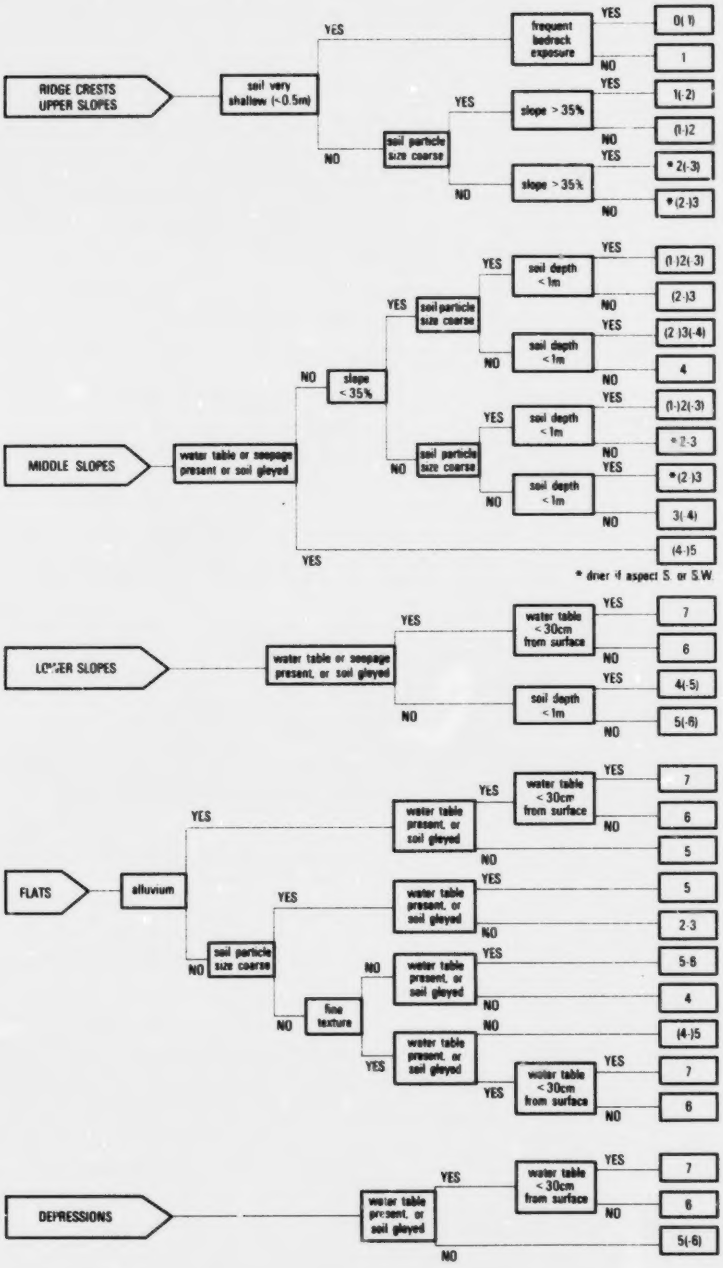
RIDGE CRESTS UPPER SLOPES
soil very shallow (<0.5m)
YES
frequent bedrock exposure
YES
0(-1)
NO
1
NO
soil particle size coarse
YES
slope > 35%
YES
1(-2)
NO
(1-)2
NO
slope > 35%
YES
* 2(-3)
NO
*(2-)3
MIDDLE SLOPES
water table or seepage present or soil gleyed
NO
slope < 35%
YES
soil particle size coarse
YES
soil depth < 1m
YES
(1-)2(-3)
NO
(2-)3
NO
soil depth < 1m
YES
(2-)3(-4)
NO
4
NO
soil particle size coarse
YES
soil depth < 1m
YES
(1-)2(-3)
NO
* 2-3
NO
soil depth < 1m
YES
*(2-)3
NO
3(-4)
YES
(4-)5
* drier if aspect S. or S.W.
LOWER SLOPES
water table or seepage present, or soil gleyed
YES
water table < 30cm from surface
YES
7
NO
6
NO
soil depth < 1m
YES
4(-5)
NO
5(-6)
FLATS
alluvium
YES
water table present, or soil gleyed
YES
water table < 30cm from surface
YES
7
NO
6
NO
5
NO
soil particle size coarse
YES
water table present, or soil gleyed
YES
5
NO
2-3
NO
fine texture
NO
water table present, or soil gleyed
YES
5-6
NO
4
YES
water table present, or soil gleyed
NO
(4-)5
YES
water table < 30cm from surface
YES
7
NO
6
DEPRESSIONS
water table present, or soil gleyed
YES
water table < 30cm from surface
YES
7
NO
6
NO
5(-6)

FIGURE 21. Key to the identification of potential hygrotopes - part 2.

TABLE 14. Key to the identification of trophotopes - part 1

This key was devised to aid field staff in the Vancouver Forest Region in the identification of trophotope using readily observable environmental and soil properties. It is intended to be used in conjunction with indicator plant analysis. It should be assessed on the basis of soil examinations to a depth of at least 30 cm (from the top of the mineral soil) in several locations on the site.

Category	Definition
Alluvial soils	soils that are found on active floodplains; inactive floodplains (e.g. those on higher terraces) should be considered under "other soils"; alluvial soils feature (a) fluctuating or moving water table at a depth > 30 cm (or overland flow during flooding), and (b) deposition of materials carried by water.
Seepage soils	soils that feature permanent or temporary moving groundwater within the rooting zone during the growing season (may be indicated by mottled horizons).
Waterlogged soils	organic or gleysolic soils that feature a temporary or permanent water table < 30 cm (rarely < 50 cm) from the ground surface. They are typically found on flats or in depressions.
Ae horizon	a leached horizon in the upper soil profile characterized by a greyish colour. A well-developed Ae is > 2 cm thick[1].
Soil light coloured	soils that have a low organic matter content; such soils may have various colours which due to low organic matter content make them appear light or bright.
Soil particle size coarse	sandy[2] texture with > 35% coarse fragments or loamy[2] texture with > 70% coarse fragments.
Soil base-low	soils formed from parent materials dominated by coarse fragments of low base status.

---

[1] Carter, R.E., K. Klinka, H. Schreier, and L.M. Lavkulich. 1985. Ecological approach to differentiating podzols in coastal southwestern British Columbia. Province of British Columbia, Ministry of Forests. (in print).

[2] Sandy - LS,S; loamy - SL,L,SCL.

TABLE 14. (continued)

Category	Definition
Mor	humus form comprised of predominantly F and H horizons; the F horizon being matted with common fungal mycelia.
Hydromor[3]	poorly aerated Mor humus form under conditions of prolonged saturation by water
Histomor[3]	poorly aerated Mor humus form under conditions of more or less permanent saturation by water. They are comprised of poorly decomposed, fibrous peat material.
Hydromull[3]	poorly aerated Mull humus form under conditions of prolonged saturation by water. They are dominated by Ah horizons, the F and H horizons being very thin.
Saprimull[3]	poorly aerated Mull humus form under conditions of more or less permanent saturation by water. They are comprised of well decomposed, saturated organic materials.

[3] For reference to humus form terminology see Klinka *et al*. (1981).

Ideally, the hygrotope and trophotope of a site inferred from both environmental and indicator plant analyses should agree because vegetation is considered to be one of the best expressions of the integrated effects of all factors influencing an ecosystem. However, this may not be the case in all situations since vegetation also responds to biotic factors such as stand density, competition, and animal populations, as well as to short-term disturbances or treatments such as fire or fertilization. As a result, it is important to keep in mind that in some situations the results of indicator plant analysis will not correlate clearly with the environmental analysis.

For example, a sparse moss flora developed under the dense canopy of immature coniferous stands will not likely be sufficient for a meaningful indicator plant analysis, as it will tend to indicate low light and the relatively cool and humid microclimatic conditions of these communities. Similarly, the initial seral vegetation developed on sites affected by harvesting and fire will be more indicative of processes taking place in the forest floor and uppermost soil layer rather than their edatopes. In such cases, emphasis should be placed on the results of the environmental analysis.

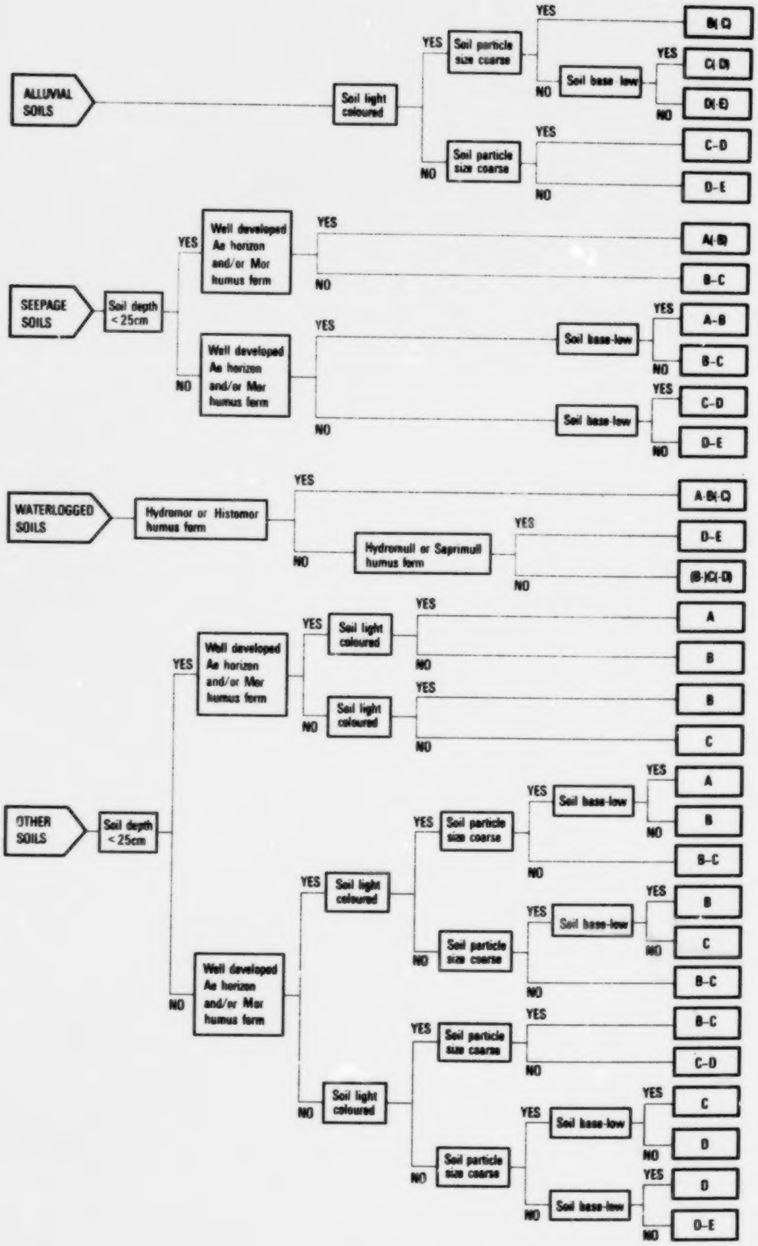

FIGURE 22. Key to the identification of trophotopes - part 2.

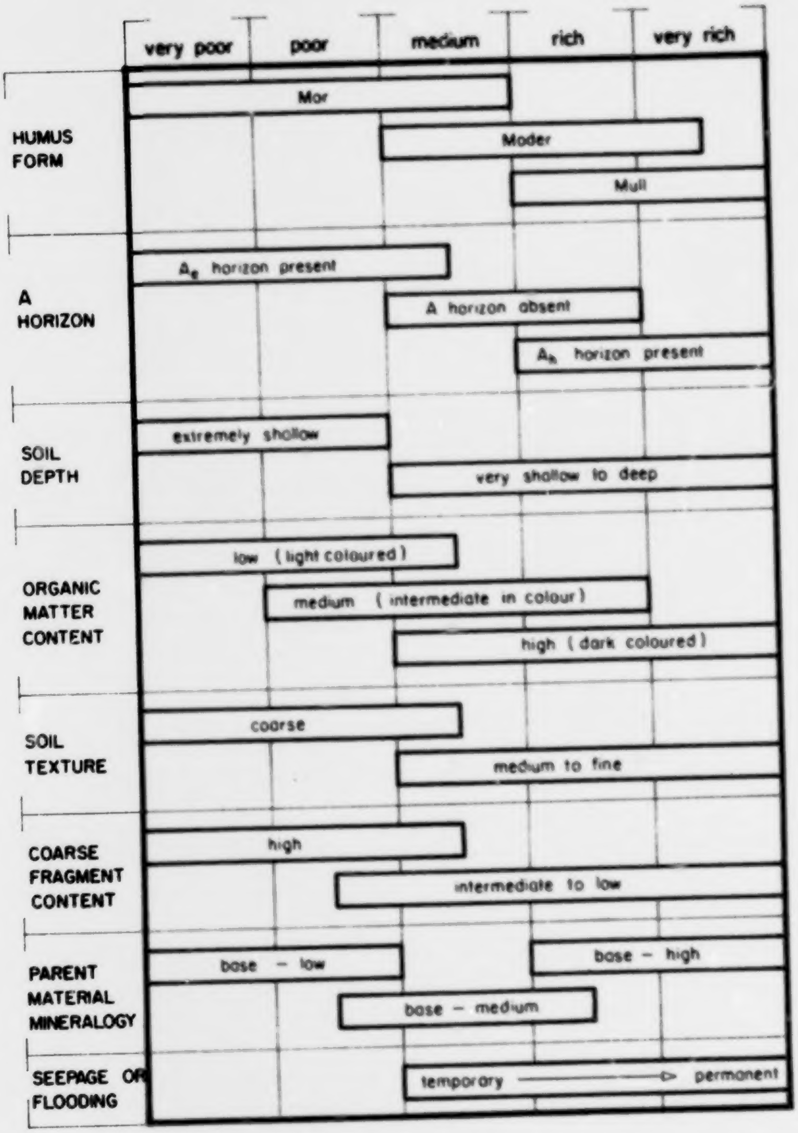

FIGURE 23. Relationships between site properties and trophotope.

In other cases, the indicator plant analysis may strongly reflect a high coverage of thick, acid, decaying wood materials in the forest floor. Under these conditions, the trophotope inferred from the indicator plant analysis is invariably in the nutrient-very poor to medium range. Often this occurs regardless of the other soil properties which may infer a somewhat richer trophotope when considered on their own. In such cases, the vegetation is responding to properties of the uppermost soil layers which may not reflect the potential capability of the site to supply nutrients. The potential capability of the site may be realized through treatment of the forest floor to improve its decomposition rate.

2.5.4 Setting Examination

The examination of a setting, i.e., the identification and diagnosis of component sites, is most profitable when conducted at the pre-harvesting stage. At this time, the indicator plant analysis will yield the most informative results and there will be options for designing a site-specific treatment strategy. Site diagnosis can be applied successfully on cutover areas; however, in such cases greater emphasis must be placed on environmental features and treatment options will be limited.

The objective is to recognize and stratify the proposed setting area into component sites. Figure 24 shows a sequence of steps which should be followed for setting examination. Initial subdivision of the area into tentative sites can be done using mainly physiographic features such as slope, slope position, and aspect. Topographic maps, air photos or soil maps (if available) can be used for this purpose.

Field sampling is required to determine quality of the recognized sites and to verify the initial subdivision. The strategy of the field examination should be to determine a pattern of significantly different sites, assessing as much of the area as is feasible. This can be carried out systematically, as part of the operational cruise, or it can be done through an informal traverse of the area. Site diagnosis should be conducted on approximately $400m^2$ sample plots with sufficient frequency to characterize the major and extreme sites. Following the procedures described in Sections 2.5 and 4.3, the site quality and site sensitivity to fire, respectively, for the site(s) can be determined. Based on this, the most appropriate site-specific treatments can be proposed, and in turn, boundaries may be revised or a sequence of treatments proposed to allow their most feasible application.

The result of the setting examination is usually a map showing the distribution and quality of its component site(s) (Figure 25). Following the principles outlined in Sections 3 and 4 of the report, site-specific decisions on tree species selection and slashburning can be made. It may occur that the same or very similar treatment options will be adopted for

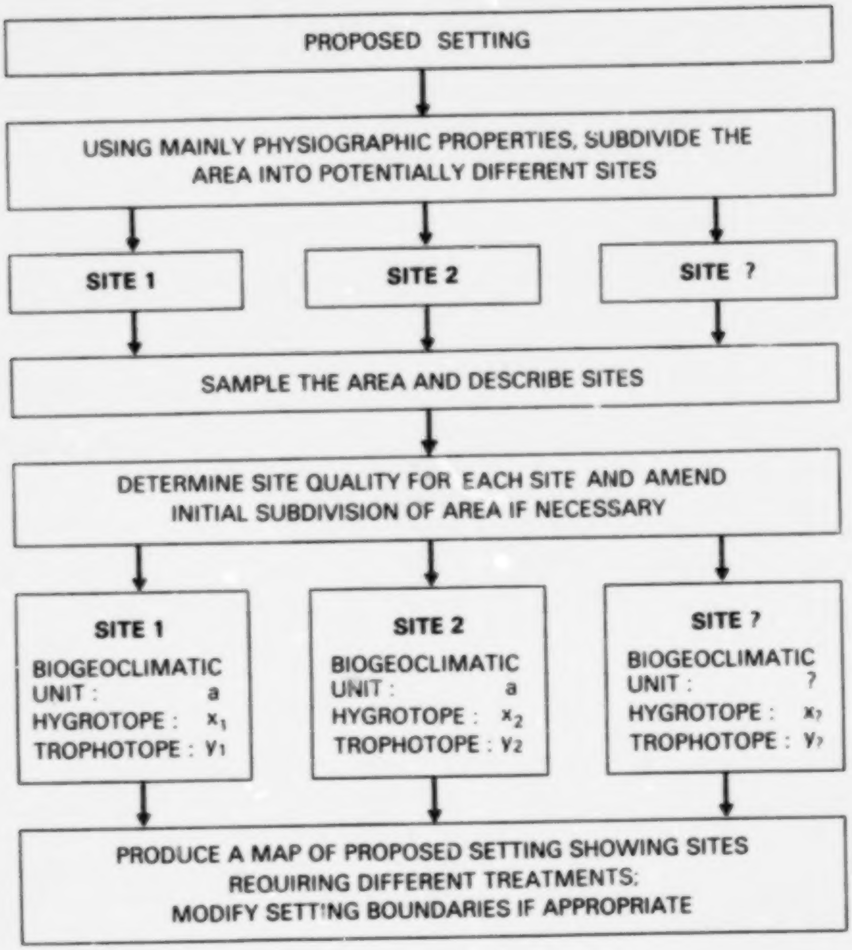
PROPOSED SETTING
USING MAINLY PHYSIOGRAPHIC PROPERTIES, SUBDIVIDE THE AREA INTO POTENTIALLY DIFFERENT SITES
SITE 1
SITE 2
SITE ?
SAMPLE THE AREA AND DESCRIBE SITES
DETERMINE SITE QUALITY FOR EACH SITE AND AMEND INITIAL SUBDIVISION OF AREA IF NECESSARY
SITE 1
BIOGEOCLIMATIC UNIT : a
HYGROTOPE : x1
TROPHOTOPE : y1
SITE 2
BIOGEOCLIMATIC UNIT : a
HYGROTOPE : x2
TROPHOTOPE : y2
SITE ?
BIOGEOCLIMATIC UNIT : ?
HYGROTOPE : x?
TROPHOTOPE : y?
PRODUCE A MAP OF PROPOSED SETTING SHOWING SITES REQUIRING DIFFERENT TREATMENTS;
MODIFY SETTING BOUNDARIES IF APPROPRIATE

FIGURE 24. **Flowchart illustrating steps for site diagnosis and mapping of a setting.**

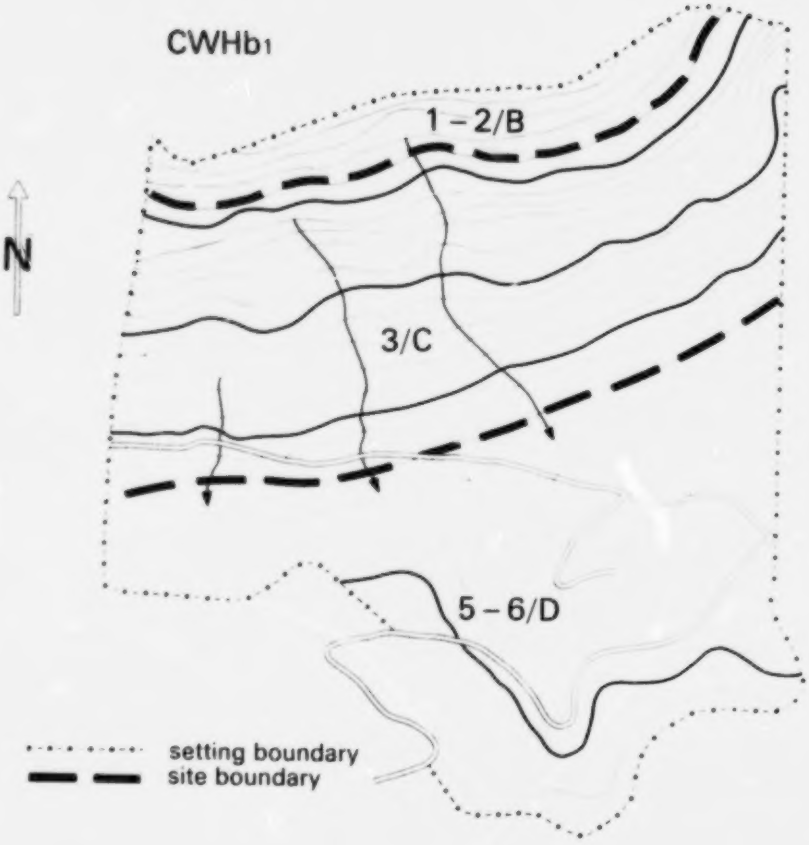

FIGURE 25. Subdivision of a setting into major component sites.

two or more component sites. In such cases these related sites can be treated as one unit. In other cases the component sites may have distinctly different qualities, thus requiring different treatments. If the differences are confined primarily to the tree species choice, the setting should be proposed for multi-species regeneration. However, if the differences are confined to slashburning prescriptions, a decision must be made to either (a) revise the setting boundaries, (b) propose cutting sequence so each site can be treated independently, or (c) prescribe a treatment for the whole setting which will aim to provide a balance between favourable and adverse effects. For example, sites with very high sensitivity to fire may occur over 50% of the setting, while the remainder is made up of sites with a low sensitivity class. Clearly, a single treatment over the whole setting may benefit part of it, but may be detrimental to the remainder.

3. TREE SPECIES SELECTION GUIDELINES

3.1 Synopsis

Selecting the best tree species for reforestation is a critical decision in forest management. Ideally, this decision requires knowledge of the ecological characteristics of forest trees, sites, and ecosystems, and definition of the intent, goal, strategy, and objective of forest management. This knowledge can be used to develop criteria for selecting the most suitable tree species (alone or in combination) for a given site. The criteria used in these tree species selection guidelines are: maximum sustainable productivity, crop reliability, and silvicultural feasibility. General background for the species selection guidelines has been described by Nuszdorfer and Klinka (1982).

3.2 Principles of Tree Species Selection[1]

The appropriate tree species for a managed forest are those which are ecologically viable on the site in question and which are best suited to management objectives. Therefore, the selection will depend on (Figure 26):

(a) ecological factors - the ecological characteristics of forest trees, sites, and managed forest ecosystems,

(b) management factors - the intent, goal, strategy and objective of forest management,

(c) the criteria used to determine the suitability of tree species for different management conditions.

3.2.1 Ecological Factors

The first step in the process of selection is to determine which species are ecologically suitable for a given site. This information can be obtained from Krajina (1969) and B.C. Ministry of Forests regional ecosystem studies.

An ecological and ecosystem-specific approach to tree species selection has been adopted here. This is necessary because each tree species is adapted to a certain range of environmental conditions, and as such its

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[1] Based on Klinka and Feller (1984).

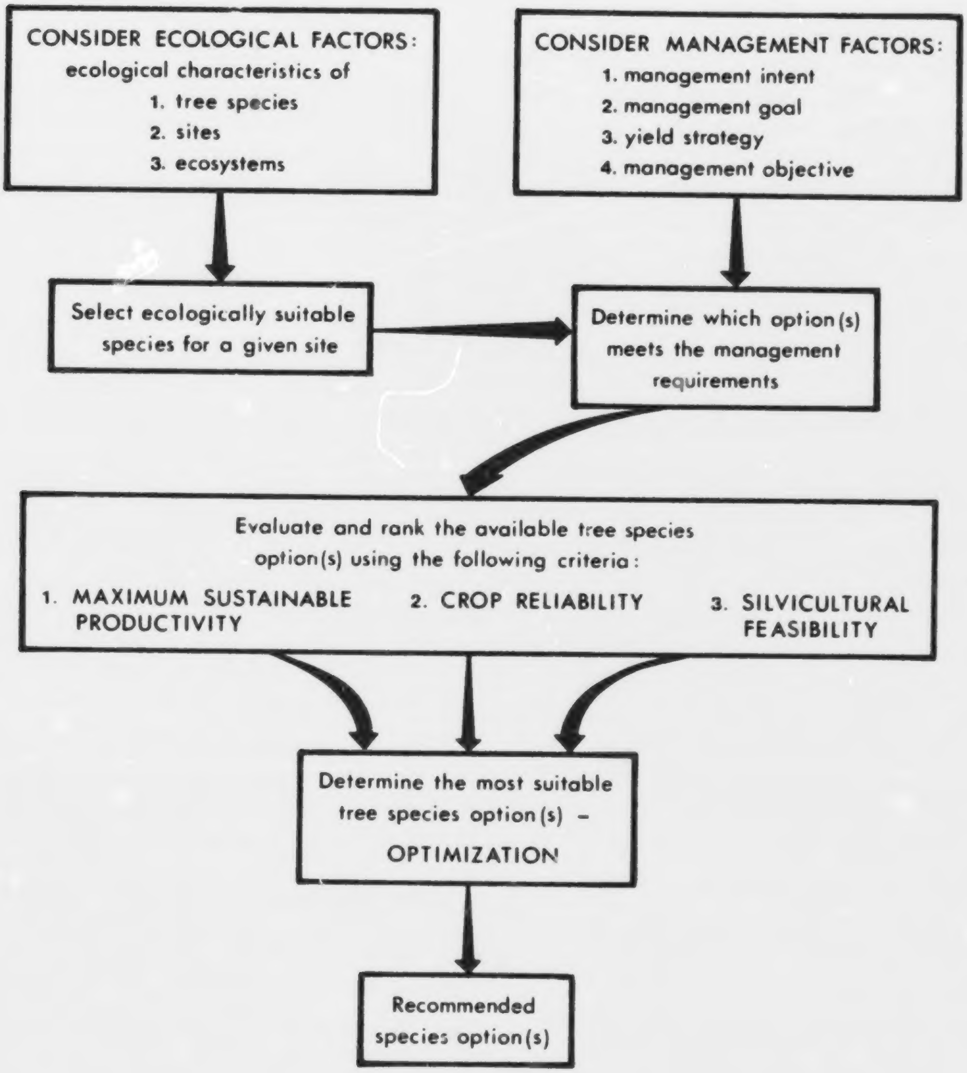
CONSIDER ECOLOGICAL FACTORS:
ecological characteristics of
1. tree species
2. sites
3. ecosystems
CONSIDER MANAGEMENT FACTORS:
1. management intent
2. management goal
3. yield strategy
4. management objective
Select ecologically suitable species for a given site
Determine which option(s) meets the management requirements
Evaluate and rank the available tree species option(s) using the following criteria:
1. MAXIMUM SUSTAINABLE PRODUCTIVITY
2. CROP RELIABILITY
3. SILVICULTURAL FEASIBILITY
Determine the most suitable tree species option(s) – OPTIMIZATION
Recommended species option(s)

FIGURE 26. The conceptual approach used for tree species selection decision-making. The selection criteria are those factors satisfying the management intent of timber production.

growth and behaviour depends on the ecosystems or sites in which it grows. In an unfavorable environment for a species, its growth potential will not be realized, its susceptibility to damaging agents will increase, or more input for its establishment and growth will be required. Thus, to ecologically match species and treatments with a site, we must have (a) an appropriate ecological classification system and (b) knowledge of the ecological characteristics of forest trees, sites, and forest ecosystems.

The biogeoclimatic ecosystem classification system, developed by Dr. V.J. Krajina and his students, has provided ecosystem units suitable for tree species selection as well as much information regarding the ecological characteristics of tree species, forest sites, and natural ecosystems.

Ecosystem studies conducted in southwestern B.C. have generally found that only environmentally extreme sites support commercial growth of a single species. Most forest sites can support a variety of tree species, although the actual stand composition depends greatly on the successional stage of the ecosystems and local tree species diversity. On many forest sites a silviculturist can choose from a number of tree species when making reforestation decisions.

3.2.2 Management Factors

The second step in the selection process is a consideration of management factors. At this stage ecologically viable options are evaluated to determine which option best meets the management requirements. These requirements are effective at four levels: intent, goal, strategy, and objective. For the management intent of timber production and the management goal required by B.C. government policy, we have adopted a sustained yield strategy based on site carrying capacity, without constant input of material and energy. Different management objectives may require amendments to the tree species chosen in the selection guidelines, but in most cases different silvicultural regimes will be more appropriate.

3.2.3 Selection Criteria

For the management requirements stated above, three selection criteria have been used to determine the most suitable tree species: maximum sustainable productivity, crop reliability, and silvicultural feasibility.

3.2.3.1 Maximum Sustainable Productivity

To satisfy the first criterion of species selection, the most productive tree species or combination of tree species should be selected for a given site. These species must fully utilize the site without lowering the site potential for growing subsequent timber crops.

There has been a lack of ecosystem yield tables for managed stands in British Columbia. However, because of the availability of much site index data and the relative ease with which further data could be obtained, productivity of all tree species-site combinations could be estimated using site index (m/100 yrs) based on top height. Generalized site units were produced by the biogeoclimatic ecosystem classification. Site index data determined by Krajina (1969) and those collected in the regional ecosystem studies from unmanaged stands were used for productivity ranking. Other factors influencing timber production, such as shade tolerance, spatial requirements of crowns, and form factor, were considered in the productivity ranking.

The potential increase in forest productivity by establishing mixed-species stands must be considered when determining the species selection guidelines for a particular site. The choice between a single species and a mixture of species depends on site characteristics and species compatibility. When ecological and stand history data indicate a potentially merchantable crop from stratified canopy mixed-species stands, one should consider the productivity of the possible multiple-species options. In southwestern British Columbia, fresh to moist and nutrient-medium to very rich sites were evaluated as most suitable for mixed-species stands, while the combinations of very dry or very wet and nutrient-very poor were least suitable. The tree species selection guidelines for the composition and structure of the most productive mixed-species stand were based upon available information on shade tolerance and spatial requirements of tree species in single-species or mixed-species stands, as well as available information on growth and yield.

Present trends suggest that second growth forests in the Vancouver Forest Region will consist of more or less even-aged forest stands established by planting, natural regeneration, or a combination of both methods. These stands will vary in their tree species composition, productivity, and structure according to site characteristics.

Irrespective of tree species, six major structural types of forest stands are recognized:

1. Non-stratified stand structure

   1.1 single-canopy, single-crop-species stands (Figure 27),
   1.2 single-canopy, two-crop-species stands (Figure 28).

2. Stratified stand structure

2.1 double-canopy, mixed stands of a crop species and a non-crop species (Figure 29),
2.2 double-canopy, mixed stands of a minor, less shade-tolerant crop species and a major more shade-tolerant crop species (Figure 30),
2.3 double-canopy, mixed stands of a major, less shade-tolerant crop species and a major, more shade-tolerant crop species (Figure 31),
2.4 multiple-canopy, mixed stands of several major crop species of different tolerances to shade (Figure 32).

Non-stratified single-canopy mixtures are likely to be less productive than pure stands of any one of the component species. In such mixtures, the production potential of the fastest growing species is diluted by intermingling less productive species among more productive species. Stratified double-canopy mixtures of compatible species (compatible primarily with respect to light requirements) are likely to be more productive than pure stands of any one of the component species. Establishment of an even-aged stand of usually no more than two or three species will maximize production. Such a stand would consist of a less shade-tolerant species in the upper layer with one or two more shade-tolerant species in the lower tree layer. This would result in maximum utilization of the above- and belowground growing space.

When selecting compatible tree species for a mixed-species stand, in addition to considering shade tolerance, one should also evaluate nutritional characteristics of tree species and the effects of those species on soil fertility. Successive harvesting of timber crops will always cause removal of nutrients from the soil. This may be aggravated by management practices. There are, however, some opportunities to conserve or replenish the nutrient reserve of a site through selection of species, genotypes, and the use of plants living in symbiosis with nitrogen-fixing organisms. This, together with selection of appropriate treatments will help overcome the adverse effects of harvesting and sustain or even increase site productivity.

3.2.3.2 Crop Reliability

To satisfy the second criterion of species selection, the established stand should be both resistant and resilient to potential hazards so that the stand will survive to time of harvest. These hazards include animals, insects, fungi, wind, snow, frost, drought, fire, and floods. Some hazards cannot be entirely avoided but their effects can be minimized by ecologically and genetically sound tree species selection and appropriate stand treatments.

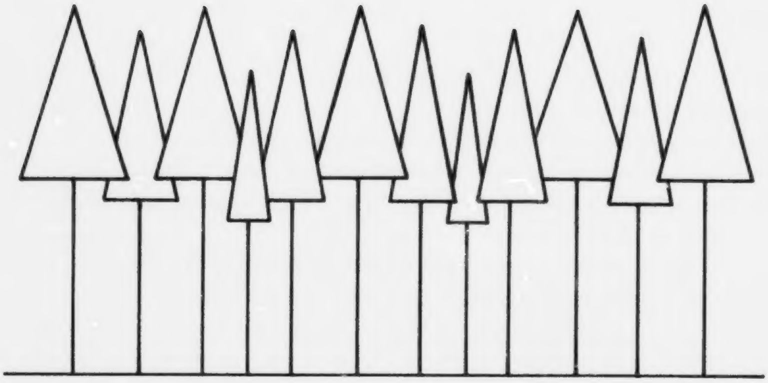

FIGURE 27. The structure of a single-canopy, mature, even-aged, single-crop species stand showing relative position of the dominant and codominant crown classes.

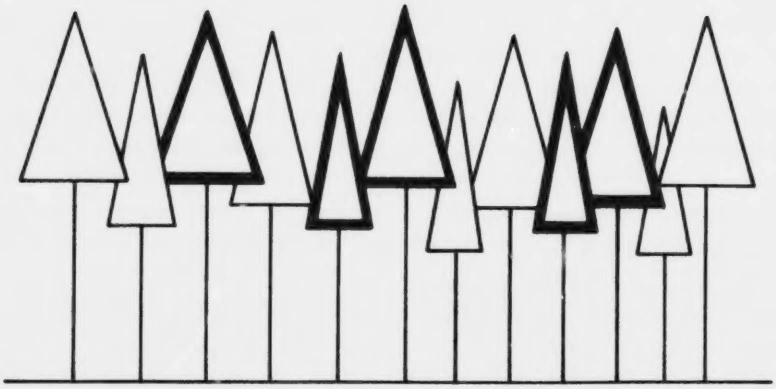

FIGURE 28. The structure of a single-canopy, mature, even-aged, two-crop-species stand. This stand structure is applicable only to those species that will grow at very similar rates and have very similar tolerances to shade (for example, Fd-Se mixtures in the CWHb5 Variant).

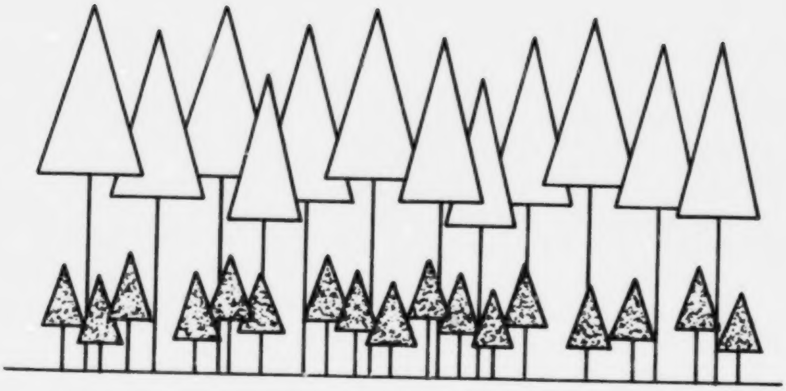

FIGURE 29. The structure of a double-canopy, mature, even-aged, mixed stand of a crop species and a non-crop species. The lower stratum is usually younger and estabished naturally. This sketch approximates a Fd-Cw mixture on dry sites.

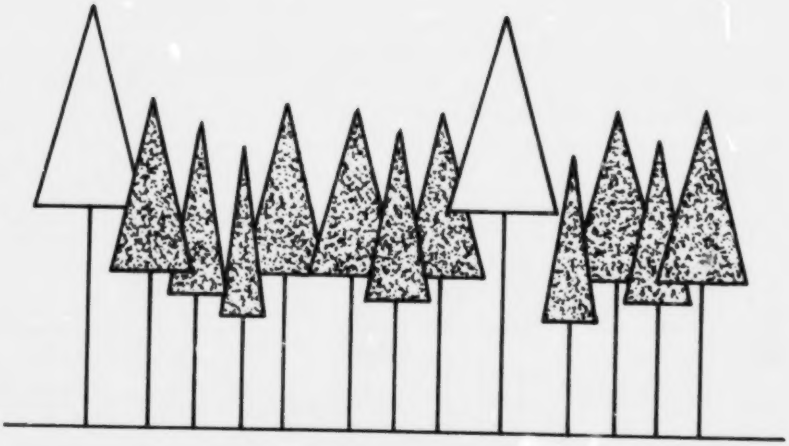

FIGURE 30. The structure of a double-canopy, mature, even-aged stand composed of a minor, less-shade-tolerant crop species and a major, more-shade-tolerant crop species. This sketch approximates Pw-Fd, or Py-Fd mixtures.

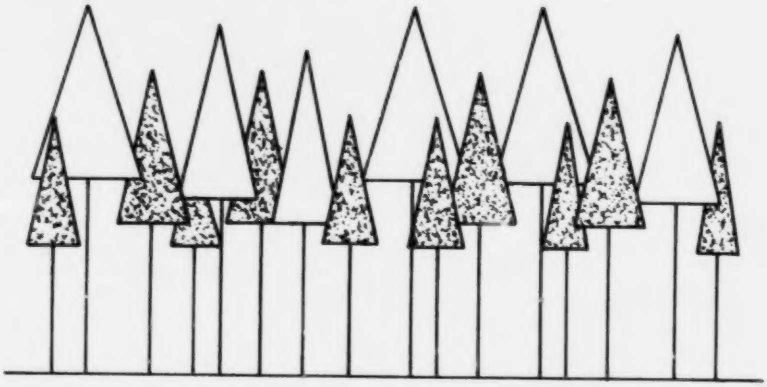

FIGURE 31. The structure of a double-canopy, mature, even-aged, mixed stand composed of two major crop species in which one species is more shade-tolerant than the other. This sketch approximates Fd-Cw, Hw-Cw, Hw-Ba, or Se-Ba mixtures.

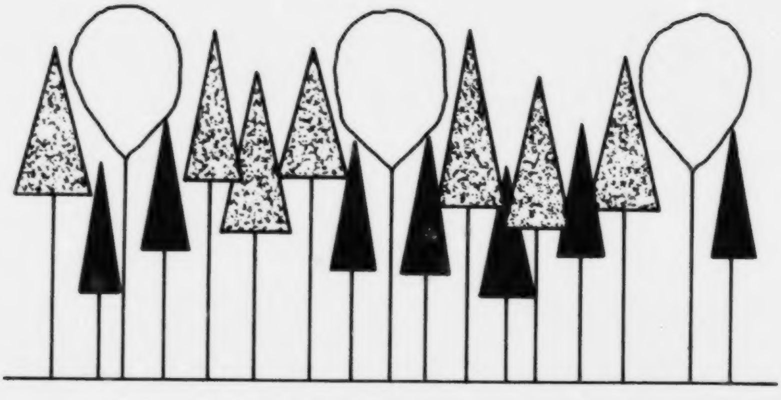

FIGURE 32. The structure of a multiple-canopy, mature, even-aged, mixed stand composed of three crop species. This sketch approximates a Ac-Ba-Cw mixture as one of the recommended options for active alluvial floodplains in the CWHa Subzone.

Crop reliability studies have concluded that (a) stands with composition and structure similar to that found naturally in any given area are more resistant and more resilient to various local hazards, (b) many of these hazards can be minimized by establishing mixed-species stands, and (c) appropriate genetic stock can be chosen to suit the prevailing biotic and abiotic environment in order to maintain stand health.

In order to adhere to the criterion of crop reliability, a tree species that is very productive on a given site but also very susceptible to environmental hazards, was not recommended for a pure stand or as a major species in a mixed-species stand. In such cases, a mixed-species stand or a less productive but more resistant species was selected.

3.2.3.3 Silvicultural Feasibility

To satisfy the final criterion of species selection, the species option(s) to be recommended should provide the most biologically- and cost-effective silvicultural system appropriate to the adopted management objective. Each tree species option will require a somewhat different series of silvicultural treatments during the life of a stand. The most suitable forest stand is not necessarily the most productive or the most inexpensive to harvest - one must also consider the cost of all treatments required to produce the desired crop.

The purpose of applying this selection criterion is to identify and avoid those tree species options which will probably require more expensive treatments than other options, not to determine the optimum series of treatments irrespective of the intensity of silviculture currently practiced. On the basis of accumulated silvicultural experience and ecosystem studies, each tree species option was examined with respect to probable cost of establishment, maintenance, and tending. The silvicultural treatments considered were: site preparation, regeneration, vegetation control, and fertilization, i.e. treatments either essential for maintaining timber production or effective in increasing nutrient supply. Tree species options requiring the fewest and most effective treatments were ranked as silviculturally most feasible.

3.2.4 Integration of the Selection Criteria

Selection of tree species composition for a managed stand requires optimization of the criteria discussed above. Even though objective mathematical techniques to solve such a problem exist, the lack of ecological and economic data necessitated a subjective assessment of the tree species options. In view of the lack of data and the subjective nature of the optimization procedure, the tree species recommendations are open to future amendments.

After ranking the available tree species options, most site units were restricted to one or two options. A few site units have such extreme characteristics that the number of viable options was severely limited and subsequent ranking dispensed with all but one of them. When the ranking indicated that none of the options had met all the criteria, priority was given to crop reliability. It was impossible to determine whether sustainable productivity or silvicultural feasibility was more important. Consequently, if the resultant first ranked options were equal, with one or more having a higher maximum sustainable productivity but the other(s) having a higher silvicultural feasibility, then all the first-ranked options were presented as alternative recommendations. The final decision should be made on a site- and situation-specific basis. Alternative options were also recommended in situations where there were a large number of uncertainties in the ranking procedure and two or more tree species options were ranked equally.

3.3 Format of the Tree Species Selection Guidelines

Tree species selection guidelines have been organized on the basis of biogeoclimatic and site units. The edatopic grid integrates the information on site quality and tree species selection. Each grid is subdivided into several site units outlined with bold lines. These site units represent groupings of closely related forest sites which (a) can support forest stands of the same composition and structure, (b) have similar production potential, and (c) can be managed by the same silvicultural system. Each forest site that is described by its biogeoclimatic unit, hygrotope, and trophotope can be located on the grid; this leads directly to the recommended tree species. When recommended tree species and characteristic indicator plant species for site units were alike in two or more biogeoclimatic units, we combined the information onto one grid to achieve the most effective presentation.

Both potential and actual hygrotope are shown on the edatopic grid. Numbers for hygrotope and letters for trophotope will continue to be used as the primary identification characteristics of site units.

Each site unit on a grid displays an identification number, the recommended tree species symbols, a productivity class symbol, and both a reference number and a representative member of each edatopic indicator species group that is characteristic of the site unit. The site unit identification number is a reference for comments regarding tree species selection guidelines which are presented beside each grid. The recommended tree species are listed in order of increasing shade tolerance. The symbols used for tree species and growth class follow the provincial standards (Tables 2 and 16). The size of the symbols indicates the projected role of a species in a mature stand (Table 15). Special alluvial floodplain subunits are recognized within fresh to moist, nutrient-medium to very rich site units for most submontane biogeoclimatic units.

TABLE 15. Classes of tree species composition

Role of species	Size of symbol	Percent contribution to the stand basal area at maturity
Major crop species	large	80% if a single crop species is present, >80% if no minor species are present; >20% if two or more major species are present
Minor crop species	small	20% or less

TABLE 16. Growth class symbols

Symbol	Class name
G	Good
M	Medium
P	Poor
L	Low

3.4 Choosing the Species

Figure 33 illustrates the sequential process of tree species selection, ideally carried out before and after harvesting operations.

The tree species (stand composition) recommended for each site unit may not represent the most suitable options for every locality and situation - they are open to amendments which should consider local biological, environmental, and management conditions.

Comments presented beside each grid provide information and alternatives to the recommended options. Other alternatives can be made by modifying the number of species, choice between major and minor species,

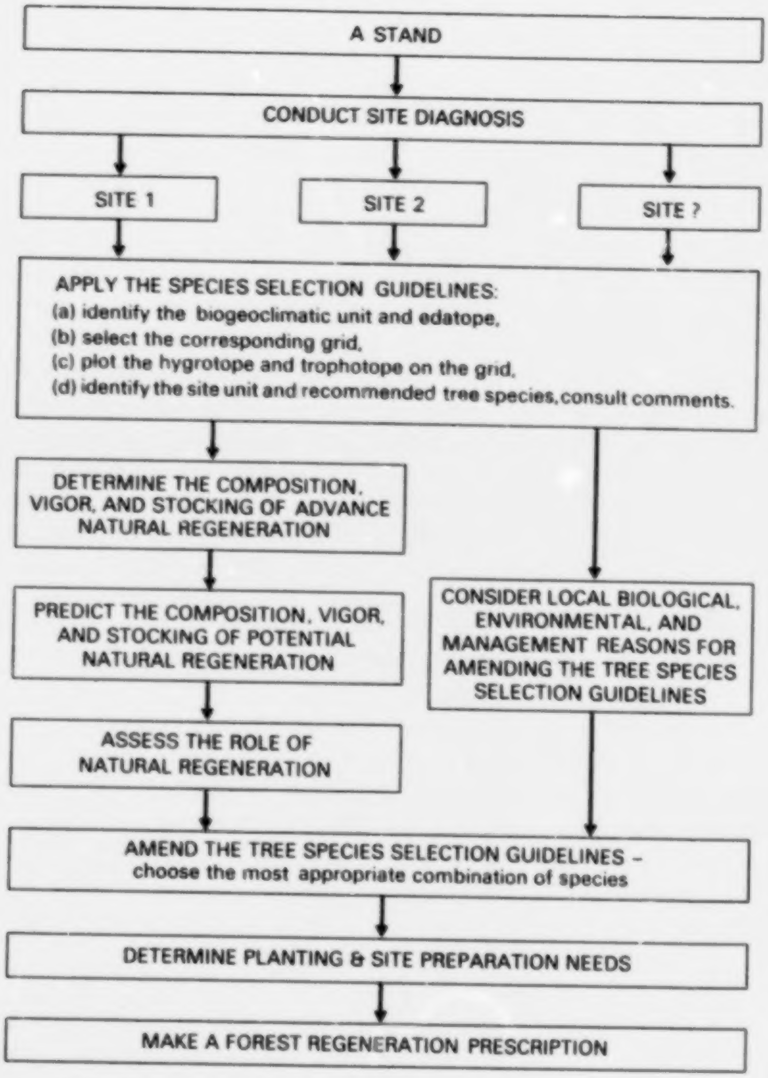
A STAND
CONDUCT SITE DIAGNOSIS
SITE 1
SITE 2
SITE ?
APPLY THE SPECIES SELECTION GUIDELINES:
(a) identify the biogeoclimatic unit and edatope,
(b) select the corresponding grid,
(c) plot the hygrotope and trophotope on the grid,
(d) identify the site unit and recommended tree species, consult comments.
DETERMINE THE COMPOSITION, VIGOR, AND STOCKING OF ADVANCE NATURAL REGENERATION
PREDICT THE COMPOSITION, VIGOR, AND STOCKING OF POTENTIAL NATURAL REGENERATION
ASSESS THE ROLE OF NATURAL REGENERATION
CONSIDER LOCAL BIOLOGICAL, ENVIRONMENTAL, AND MANAGEMENT REASONS FOR AMENDING THE TREE SPECIES SELECTION GUIDELINES
AMEND THE TREE SPECIES SELECTION GUIDELINES - choose the most appropriate combination of species
DETERMINE PLANTING & SITE PREPARATION NEEDS
MAKE A FOREST REGENERATION PRESCRIPTION

FIGURE 33. Flowchart illustrating the decision-making process in the choice of species for regeneration of forest sites on a site- and situation-specific basis.

and proportions of the major species. When amending the guidelines, one should consider the following factors:

(a) productivity and structure of second growth forest stands of different tree species growing on similar sites,

(b) hazards likely to affect local timber crops,

(c) feasibility of the silvicultural treatments required under the existing management constraints, e.g. advanced and/or potential natural regeneration of desired tree species may significantly reduce the site preparation and establishment costs.

Table 17 provides the list of grids with their number and associated biogeoclimatic units. Indicator species and recommended tree species displayed on the grids is based on unpublished data from the Vancouver Forest Region and Brooke *et al.* (1970), Klinka (1977), Mitchell and Green (1981), Yole *et al.* (1982)[1], and Moss (1983)[2].

TABLE 17. Grid number and associated biogeoclimatic unit(s)

Grid No.	Symbol	Biogeoclimatic unit
1	MHa	Maritime Forested MH Subzone
2	MHb	Submaritime Forested MH Subzone
3	ESSFf	Subcontinental Forested ESSF Subzone and related units
4	IDFe1	Southern Subcontinental IDF Variant and related units
5	IDFe2	Central Subcontinental IDF Variant and related units
6	CDF	CDF Zone
7	CWHa1	Vancouver Island Drier Maritime CWH Variant
8	CWHa2	Pacific Ranges Drier Maritime CWH Variant
9	CWHb1	Windward Submontane Maritime Wetter CWH Variant
10	CWHb2	Windward Montane Maritime Wetter CWH Variant
11	CWHb3	Leeward Submontane Maritime Wetter CWH Variant
12	CWHb4	Leeward Montane Maritime Wetter CWH Variant
13	CWHb5	Southern Submaritime Wetter CWH Variant
14	CWHb6	Central Submaritime Lower Wetter CWH Variant
15	CWHb7	Central Submaritime Upper Wetter CWH Variant
16	CWHc1	Southern Drier Submaritime CWH Variant
17	CWHc2	Central Drier Submaritime CWH Variant
18	CWHd	Hypermaritime CWH Subzone

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[1] Yole, D., J. Pojar and B. Robinson. 1982. Ecosystem classification of the Coastal Western Hemlock Zone within the Mid Coast Timber Supply Area. Province of British Columbia, Ministry of Forests, Prince Rupert Forest Region. 190 p. (unpublished manuscript).

[2] Moss, IS. 1983. Silvicultural interpretations for ecosystems in the Mid Coast Drier Transitional and Wetter Maritime subzones of the Coastal Western Hemlock Zone. Province of British Columbia, Ministry of Forests, Prince Rupert Forest Region. 138 p. (unpublished manuscript).

Comments on the Recommended Tree Species for the Maritime Forested MH Subzone (MHa) - Grid No. 1.

General comments:

-- advance natural regeneration of Ba, Hm, and Yc may provide much of the desired component of those species

-- Se is recommended as an alternative major species on the leeward slopes of the Vancouver Island Ranges

-- Bp is recommended as a minor species for the lower elevational and southern limits of the subzone on the Pacific Ranges and the leeward slopes of the Vancouver Island Ranges

-- Yc is an alternative to Ba on nutrient-very poor to medium sites or on steep slopes

Specific comments:

Site
Unit No.

1. marginal sites for timber production

2. Se is an alternative to Hm; Ba is an alternative to Yc

3. Se is an alternative to Hm; Yc is an alternative to Ba

4. Se is an alternative to Hm; Yc is an alternative to Ba; Bp can replace in part Ba; Ss is an acceptable crop species at lower elevations, in the northern part of the MHa Subzone (Port Hardy and Bella Coola Forest Districts)

5. Ba is an acceptable minor species

6. brush hazard sites; Yc should be preferred on steep slopes; Ss is an acceptable crop species at lower elevations, in the northern part of the MHa Subzone (Port Hardy and Bella Coola Forest Districts)

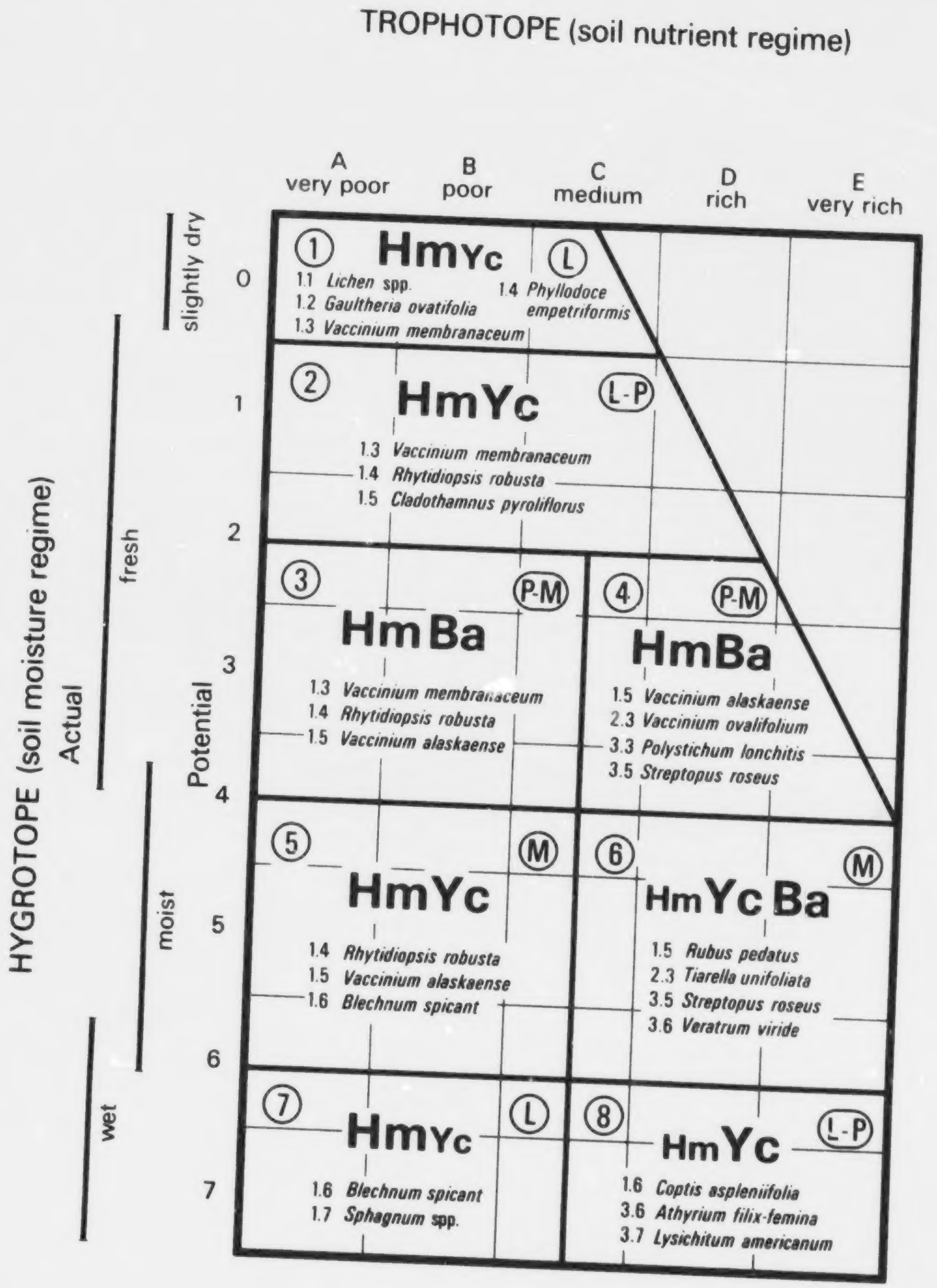
7. marginal sites for timber production

8. marginal sites for timber production; the proportion of Hm in stand composition will depend on the frequency of acid organic mounds on a site

Grid No. 1

Recommended tree species for the:

MHa	MARITIME FORESTED MH SUBZONE



① **HmYc** Ⓛ
1.1 *Lichen* spp.
1.2 *Gaultheria ovatifolia*
1.3 *Vaccinium membranaceum*
1.4 *Phyllodoce empetriformis*

② **HmYc** (L-P)
1.3 *Vaccinium membranaceum*
1.4 *Rhytidiopsis robusta*
1.5 *Cladothamnus pyroliflorus*

③ **HmBa** (P-M)
1.3 *Vaccinium membranaceum*
1.4 *Rhytidiopsis robusta*
1.5 *Vaccinium alaskaense*

④ **HmBa** (P-M)
1.5 *Vaccinium alaskaense*
2.3 *Vaccinium ovalifolium*
3.3 *Polystichum lonchitis*
3.5 *Streptopus roseus*

⑤ **HmYc** Ⓜ
1.4 *Rhytidiopsis robusta*
1.5 *Vaccinium alaskaense*
1.6 *Blechnum spicant*

⑥ **HmYcBa** Ⓜ
1.5 *Rubus pedatus*
2.3 *Tiarella unifoliata*
3.5 *Streptopus roseus*
3.6 *Veratrum viride*

⑦ **HmYc** Ⓛ
1.6 *Blechnum spicant*
1.7 *Sphagnum* spp.

⑧ **HmYc** (L-P)
1.6 *Coptis aspleniifolia*
3.6 *Athyrium filix-femina*
3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for the Submaritime Forested MH Subzone (MHb) - Grid No. 2.

General comments:

-- Hm and Yc are, in general, less desirable crop species in the eastern limits of the subzone

-- Se is a desirable crop species, particularly in the eastern limits of the subzone

-- Bp is recommended as a minor crop species in the lower and southern limits of the subzone on nutrient-medium to very rich sites

-- advance natural regeneration of Ba may provide much of the desired component in the stand composition

-- Yc is an alternative to Ba on nutrient-very poor to medium sites or on steep slopes

Specific comments:

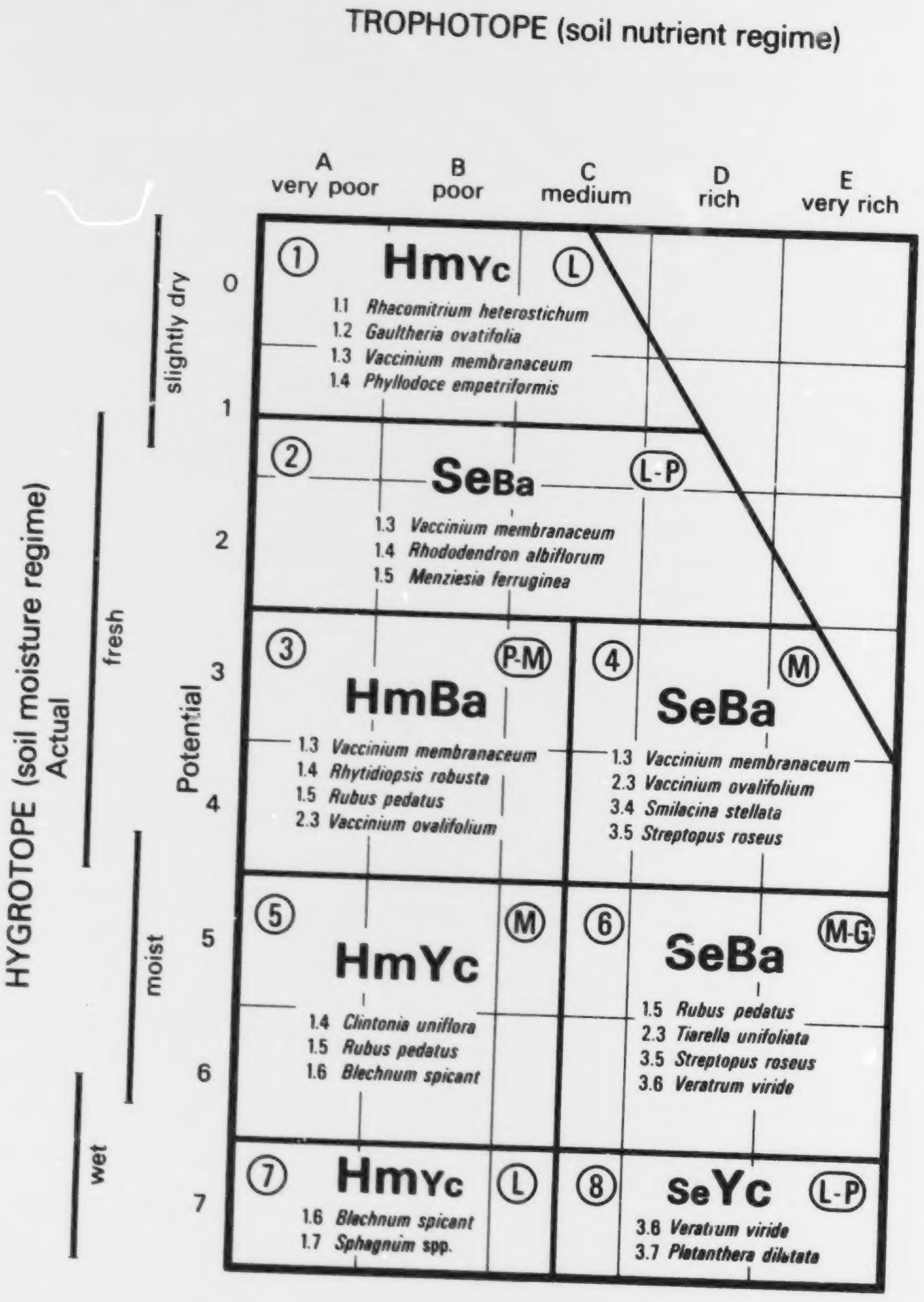
Site
Unit No.

1. marginal sites for timber production
2. Yc is an alternative to Ba
3. Se is an alternative to Hm; Yc is an alternative to Ba
4. Hm is an alternative to Se; Yc is an alternative to Ba; Bp can replace Ba in part; Pw is an acceptable minor species
5. Ba is an acceptable minor species
6. brush hazard sites; establishment of a mixed-species-stand is desirable; Yc is an alternative to Ba; Bp can replace Ba in part
7. marginal sites for timber production
8. marginal sites for timber production; Bl is an alternative to Yc

Grid No. 2

Recommended tree species for the:

MHb	**SUBMARITIME FORESTED MH SUBZONE**



① **HmYc** Ⓛ
1.1 *Rhacomitrium heterostichum*
1.2 *Gaultheria ovatifolia*
1.3 *Vaccinium membranaceum*
1.4 *Phyllodoce empetriformis*

② **SeBa** (L-P)
1.3 *Vaccinium membranaceum*
1.4 *Rhododendron albiflorum*
1.5 *Menziesia ferruginea*

③ **HmBa** (P-M)
1.3 *Vaccinium membranaceum*
1.4 *Rhytidiopsis robusta*
1.5 *Rubus pedatus*
2.3 *Vaccinium ovalifolium*

④ **SeBa** Ⓜ
1.3 *Vaccinium membranaceum*
2.3 *Vaccinium ovalifolium*
3.4 *Smilacina stellata*
3.5 *Streptopus roseus*

⑤ **HmYc** Ⓜ
1.4 *Clintonia uniflora*
1.5 *Rubus pedatus*
1.6 *Blechnum spicant*

⑥ **SeBa** (M-G)
1.5 *Rubus pedatus*
2.3 *Tiarella unifoliata*
3.5 *Streptopus roseus*
3.6 *Veratrum viride*

⑦ **HmYc** Ⓛ
1.6 *Blechnum spicant*
1.7 *Sphagnum* spp.

⑧ **SeYc** (L-P)
3.6 *Veratrum viride*
3.7 *Platanthera dilatata*

Comments on the Recommended Tree Species for the Subcontinental Forested ESSF Subzone (ESSFf) and Related Biogeoclimatic Units - Grid No. 3.

General comments:

-- along the eastern regional boundary, there is a marginal occurrence of some continental forested subzones of the ESSF Zone. Ecological differences between these subzones and the ESSFf Subzone did not necessitate a different choice of species. Therefore, the guidelines pertain to all subalpine-boreal, subcontinental to continental forests within the region

-- Ba is an alternative to Bl in the western limits of the ESSFf subzone

Specific comments:

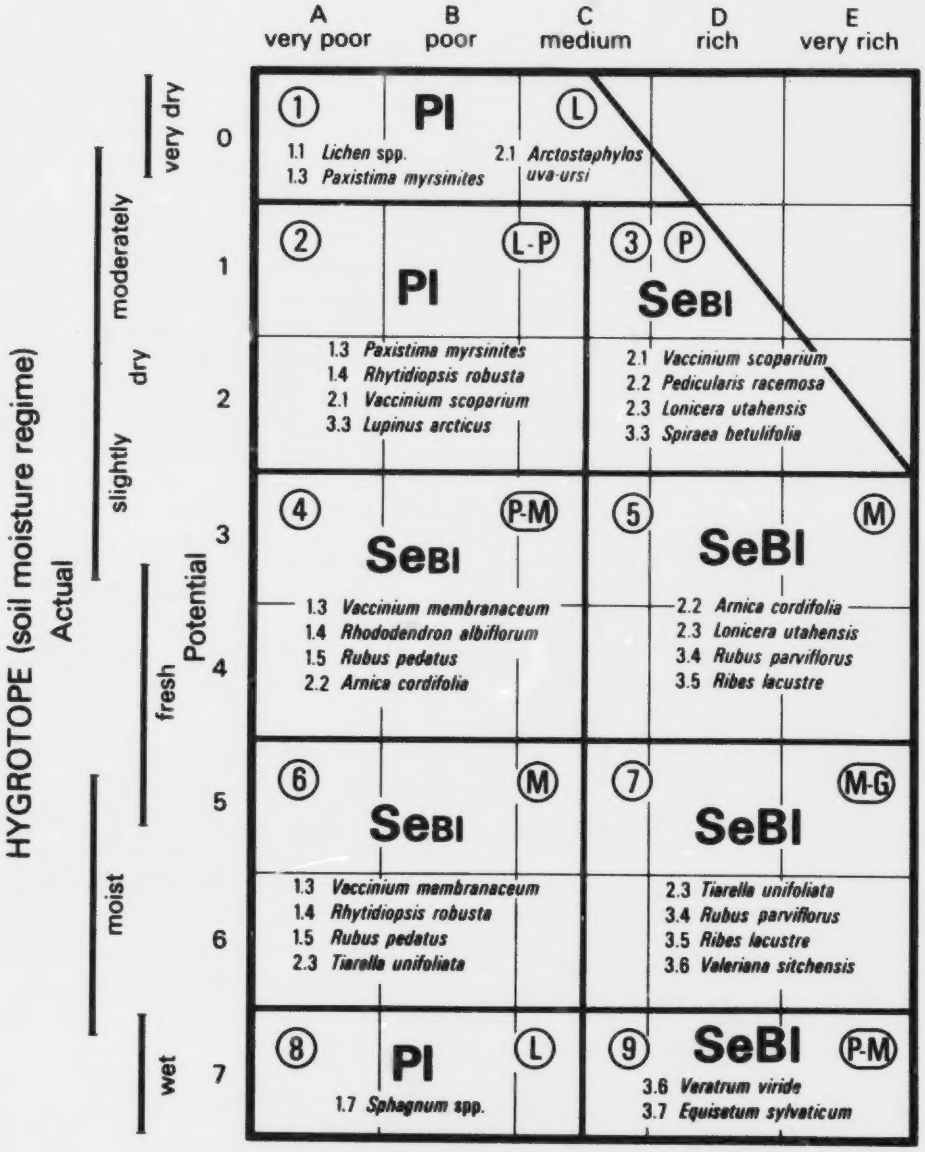
Site Unit No.	
1.	marginal sites for timber production
2.	Se is an alternative to Pl; retain Bl as nurse species, not considered for planting
3.	Fd and Pl are alternatives to Se on south facing slopes in the lower and upper limits of the subzone, respectively
4.	Pl is an alternative to Se on slightly dry sites
5.	brush hazard sites; establishment of a two-species-stand is desirable
6.	no comment
7.	brush hazard sites; establishment of a two-species-stand is desirable
8.	marginal sites for timber production
9.	brush hazard sites; Yc is an alternative to Se or Bl

Grid No. 3

Recommended tree species for the:

ESSFf	**SUBCONTINENTAL FORESTED ESSF SUBZONE AND RELATED UNITS**

TROPHOTOPE (soil nutrient regime)



① **Pl** Ⓛ
1.1 *Lichen* spp.
1.3 *Paxistima myrsinites*
2.1 *Arctostaphylos uva-ursi*

② **Pl** (L-P)
1.3 *Paxistima myrsinites*
1.4 *Rhytidiopsis robusta*
2.1 *Vaccinium scoparium*
3.3 *Lupinus arcticus*

③ Ⓟ **SeBl**
2.1 *Vaccinium scoparium*
2.2 *Pedicularis racemosa*
2.3 *Lonicera utahensis*
3.3 *Spiraea betulifolia*

④ **SeBl** (P-M)
1.3 *Vaccinium membranaceum*
1.4 *Rhododendron albiflorum*
1.5 *Rubus pedatus*
2.2 *Arnica cordifolia*

⑤ **SeBl** Ⓜ
2.2 *Arnica cordifolia*
2.3 *Lonicera utahensis*
3.4 *Rubus parviflorus*
3.5 *Ribes lacustre*

⑥ **SeBl** Ⓜ
1.3 *Vaccinium membranaceum*
1.4 *Rhytidiopsis robusta*
1.5 *Rubus pedatus*
2.3 *Tiarella unifoliata*

⑦ **SeBl** (M-G)
2.3 *Tiarella unifoliata*
3.4 *Rubus parviflorus*
3.5 *Ribes lacustre*
3.6 *Valeriana sitchensis*

⑧ **Pl** Ⓛ
1.7 *Sphagnum* spp.

⑨ **SeBl** (P-M)
3.6 *Veratrum viride*
3.7 *Equisetum sylvaticum*

Comments on the Recommended Tree Species for the Southern Variant of the Subcontinental IDF Subzone (IDFe1) and Related Biogeoclimatic Units - Grid No. 4.

General comments:

-- The IDF Zone is represented mainly by the subcontinental IDFe Subzone. In some areas, the related IDFc and IDFd subzones have been recognized. Ecological differences between these subzones and the IDFe subzone did not necessitate different choice of species; therefore, the guidelines pertain to all three subzones. Representative indicator species provided on the grid relate primarily to the IDFe1 Variant

-- Cw is applicable only in the IDFe Subzone

-- Bg is applicable only in the IDFe Subzone south of 50°N latitude

-- on a trial basis, Lw is recommended as a minor species in the upper limits of the subzones

Specific comments:

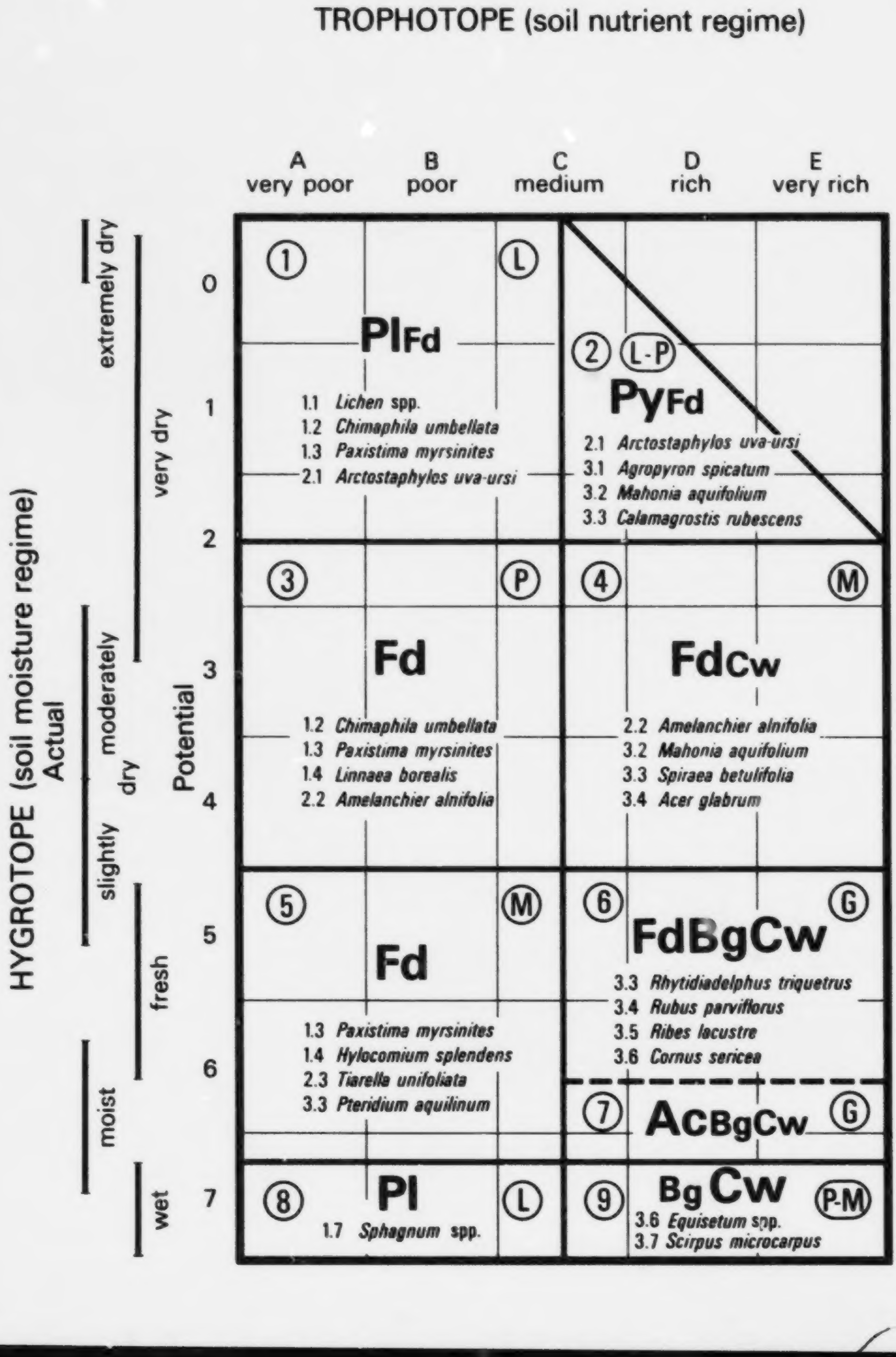
Site
Unit No.

1. marginal sites for timber production
2. marginal sites for timber production; Pl is an alternative to Py
3. Pl is an alternative to Fd; Lw is an acceptable minor species; Cw can function as a non-crop (nurse) species
4. brush hazard sites; Lw is an acceptable minor species; Py and Se are alternatives to Fd in the lower and upper limits of the subzones, respectively
5. Se is an alternative to Fd in the upper limits of the IDFd and IDFe subzones; Cw can function as a non-crop (nurse) species
6. brush hazard sites; establishment of a mixed-species-stand is desirable; Se is an alternative to Fd in the upper limits of the IDFd and IDFe subzones
7. alluvial floodplains; high brush hazard sites; Cw or Bg-Cw mixtures may be used as major species
8. marginal sites for timber production
9. brush hazard sites

Grid No. 4

Recommended tree species for the:

IDFe1	**SOUTHERN SUBCONTINENTAL IDF VARIANT AND RELATED UNITS**



Comments on the Recommended Tree Species for the Central Subcontinental IDF Variant (IDFe2) and Related Biogeoclimatic Units - Grid No. 5.

General comments:

-- undifferentiated continental subzones of the IDF may occur to the east of the IDFe2 Variant. Ecological similarity among all these units precludes the necessity for a different choice of tree species; therefore the guidelines pertain to all units

-- representative indicator species provided in the grid relate primarily to the IDFe2 Variant

-- information presented in this grid should be considered provisional due to limited data

-- Ss is susceptible to Sitka spruce weevil [Pissodes strobi (Peck)]

Specific comments:

Site
Unit No.

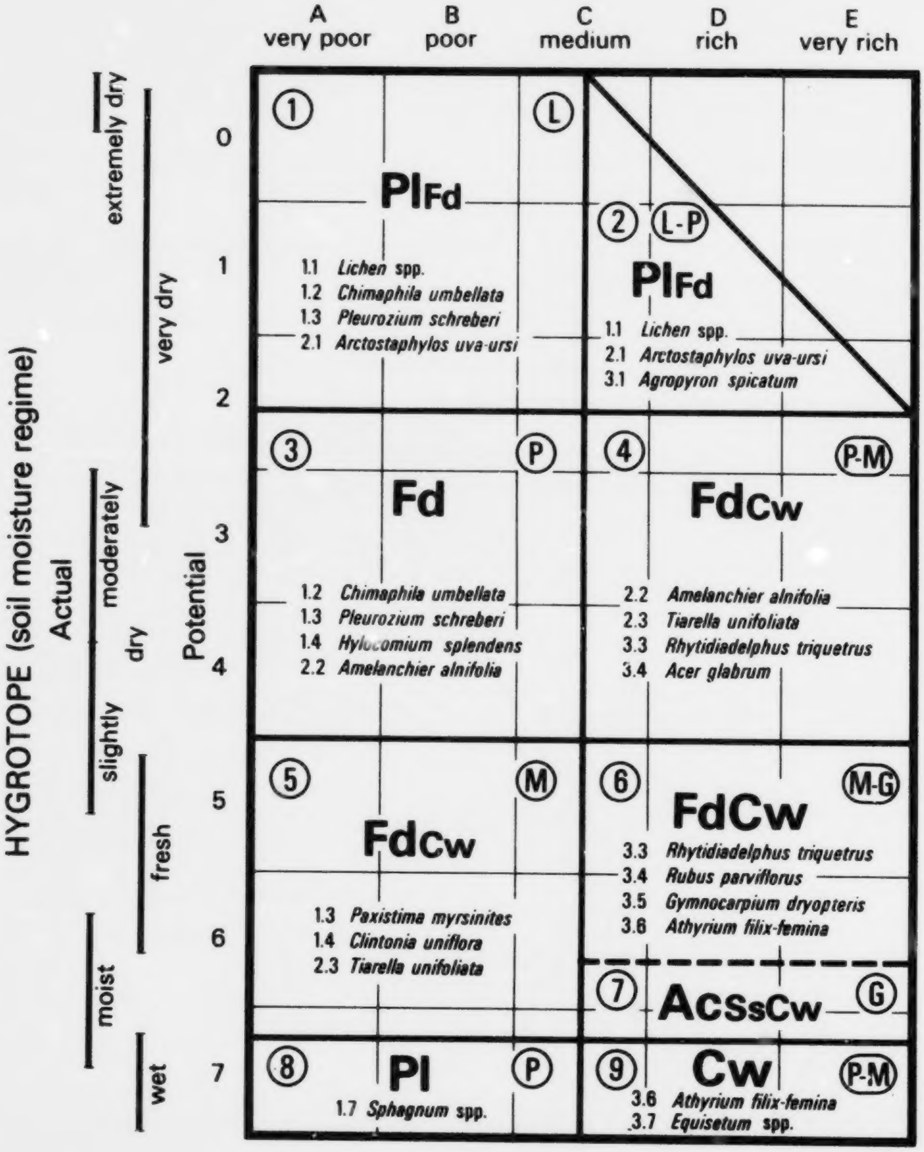
1. marginal sites for timber production
2. marginal sites for timber production
3. Pl is an alternative to Fd
4. Pl is an alternative minor species; Se is an alternative to Fd in the upper limits of the variant
5. Se is an alternative to Fd in the upper limits of the variant
6. brush hazard sites; establishment of a mixed-species-stand is desirable; Ss is an acceptable minor species
7. alluvial floodplains; high brush hazard sites; Cw or Cw-Ss mixtures may be used as major species
8. marginal sites for timber production
9. brush hazard sites; Ss is an acceptable minor species on raised mounds

Grid No. 5

Recommended tree species for the:

IDFe2	**CENTRAL SUBCONTINENTAL IDF VARIANT AND RELATED UNITS**

TROPHOTOPE (soil nutrient regime)



① (L) **PlFd**

1.1 *Lichen* spp.
1.2 *Chimaphila umbellata*
1.3 *Pleurozium schreberi*
2.1 *Arctostaphylos uva-ursi*

② (L-P) **PlFd**

1.1 *Lichen* spp.
2.1 *Arctostaphylos uva-ursi*
3.1 *Agropyron spicatum*

③ (P) **Fd**

1.2 *Chimaphila umbellata*
1.3 *Pleurozium schreberi*
1.4 *Hylocomium splendens*
2.2 *Amelanchier alnifolia*

④ (P-M) **FdCw**

2.2 *Amelanchier alnifolia*
2.3 *Tiarella unifoliata*
3.3 *Rhytidiadelphus triquetrus*
3.4 *Acer glabrum*

⑤ (M) **FdCw**

1.3 *Paxistima myrsinites*
1.4 *Clintonia uniflora*
2.3 *Tiarella unifoliata*

⑥ (M-G) **FdCw**

3.3 *Rhytidiadelphus triquetrus*
3.4 *Rubus parviflorus*
3.5 *Gymnocarpium dryopteris*
3.6 *Athyrium filix-femina*

⑦ **AcSsCw** (G)

⑧ (P) **Pl**

1.7 *Sphagnum* spp.

⑨ (P-M) **Cw**

3.6 *Athyrium filix-femina*
3.7 *Equisetum* spp.

Comments on the Recommended Tree Species for the CDF Zone - Grid No. 6.

General comments:

-- where recommended, Cw, Pw, Lw (on a trial basis) in the CDFb Subzone and Py (on a trial basis) in the CDFa Subzone are alternatives to Fd on sites affected by laminated root rot [*Phellinus weirii* (Murr.) Gilbertson]

Specific comments:

Site
Unit No.

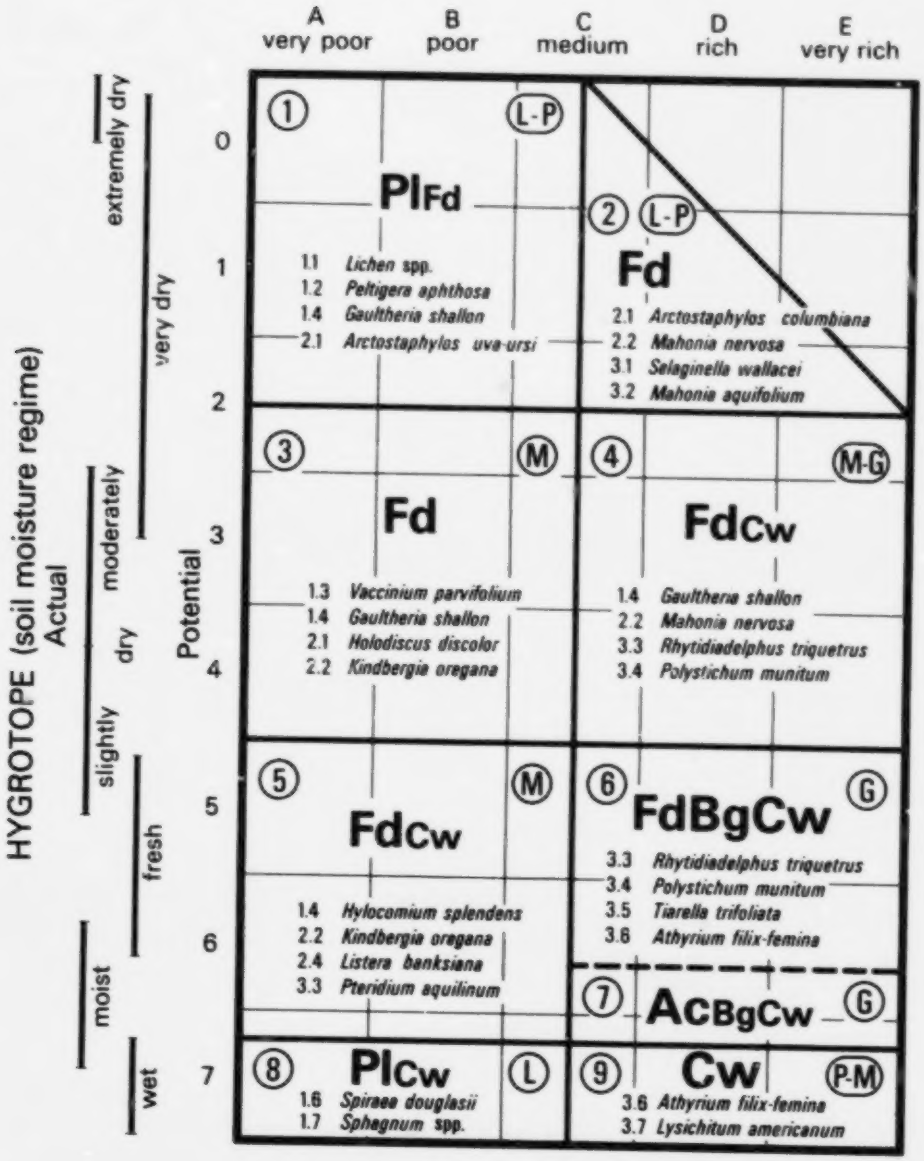
1. marginal sites for timber production
2. marginal sites for timber production; Pl or Py in the CDFa Subzone and Pl or Lw in the CDFb Subzone are alternatives to Fd
3. Cw can function as a non-crop (nurse) species to suppress a lower shrub layer of salal; Lw or Pl are alternatives to Fd
4. Py in the CDFa Subzone, and Lw or Pw in the CDFb Subzone are alternatives to Fd; Bg is an acceptable minor species
5. no comment
6. brush hazard sites; establishment of a mixed-species-stand is desirable
7. alluvial floodplains; high brush hazard sites; Bg-Cw mixtures may be used as major species
8. marginal sites for timber production
9. brush hazard sites; Hw is an acceptable minor species on acid organic mounds

Grid No. 6

Recommended tree species for the:

CDF	**CDF ZONE**

TROPHOTOPE (soil nutrient regime)



① (L-P) **PlFd**
1.1 *Lichen spp.*
1.2 *Peltigera aphthosa*
1.4 *Gaultheria shallon*
2.1 *Arctostaphylos uva-ursi*

② (L-P) **Fd**
2.1 *Arctostaphylos columbiana*
2.2 *Mahonia nervosa*
3.1 *Selaginella wallacei*
3.2 *Mahonia aquifolium*

③ (M) **Fd**
1.3 *Vaccinium parvifolium*
1.4 *Gaultheria shallon*
2.1 *Holodiscus discolor*
2.2 *Kindbergia oregana*

④ (M-G) **FdCw**
1.4 *Gaultheria shallon*
2.2 *Mahonia nervosa*
3.3 *Rhytidiadelphus triquetrus*
3.4 *Polystichum munitum*

⑤ (M) **FdCw**
1.4 *Hylocomium splendens*
2.2 *Kindbergia oregana*
2.4 *Listera banksiana*
3.3 *Pteridium aquilinum*

⑥ (G) **FdBgCw**
3.3 *Rhytidiadelphus triquetrus*
3.4 *Polystichum munitum*
3.5 *Tiarella trifoliata*
3.6 *Athyrium filix-femina*

⑦ (G) **AcBgCw**

⑧ (L) **PlCw**
1.6 *Spiraea douglasii*
1.7 *Sphagnum spp.*

⑨ (P-M) **Cw**
3.6 *Athyrium filix-femina*
3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for the Vancouver Island Drier Maritime CWH Variant (CWHa1) - Grid No. 7.

General comments:

-- Lw is recommended on a trial basis as a minor species on dry sites

-- where recommended, Cw (as a major species) or Lw and Pw (as minor species) are alternatives to Fd on sites affected by laminated root rot

-- Ss is susceptible to Sitka spruce weevil

Specific comments:

Site
Unit No.

1. marginal sites for timber production

2. Pl is an alternative to Fd; Lw is an acceptable minor species; Cw can function as a non-crop (nurse) species to suppress a lower shrub layer of salal

3. Lw or Pw are acceptable minor species

4. Hw is an alternative to Fd in the wettest part of the variant; Fd--Hw mixtures, however, are not recommended - Fd should be used as a minor to Hw, or Hw as a minor to Fd; inclusion of Cw is desirable to both Hw or Fd

5. Pw is an acceptable minor species

6. Fd is an acceptable minor species

7. brush hazard sites; establishment of a mixed-species-stand is desirable

8. alluvial floodplains; high brush hazard sites; Cw or Bg-Cw mixtures may be used as major species

9. marginal sites for timber production

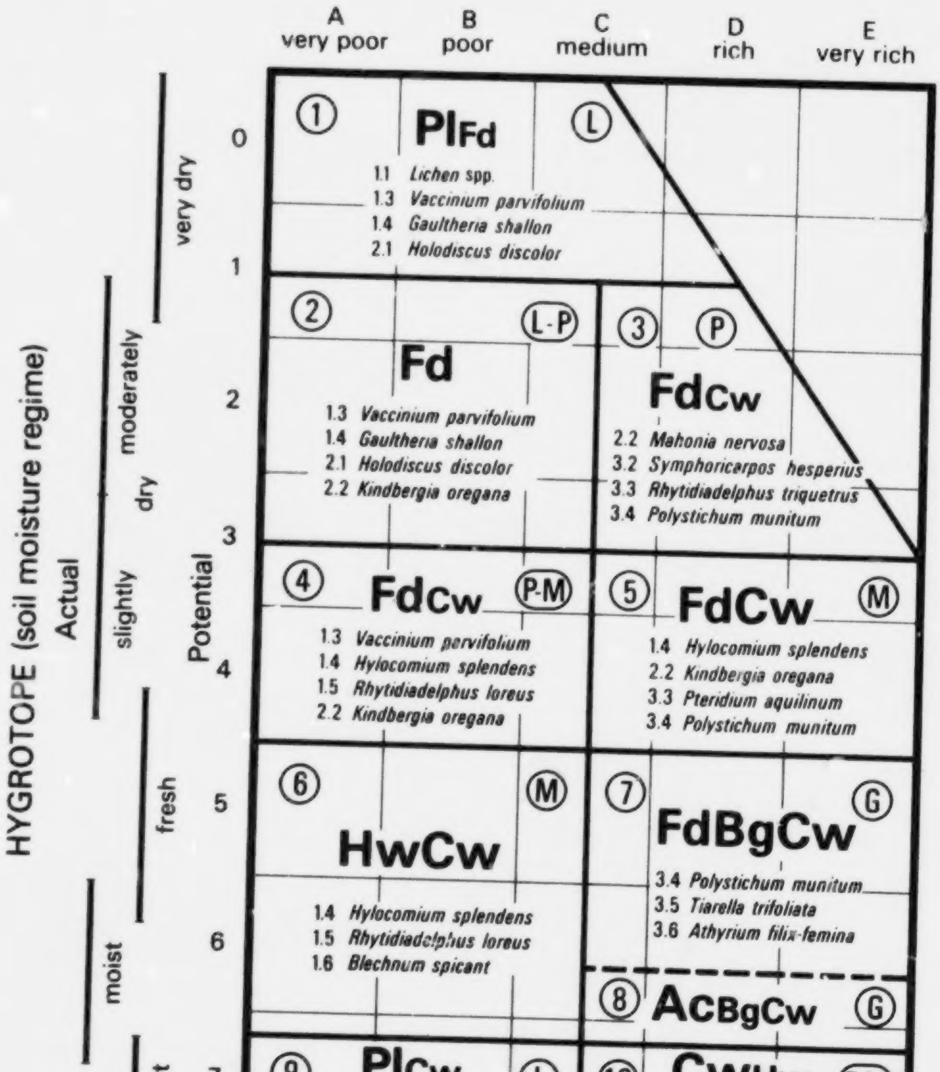
10. brush hazard sites; Pw and Ss are acceptable minor species; Hw (regenerated naturally) is an acceptable minor species, depending on the frequency of acid organic mounds on the site

Grid No. 7

Recommended tree species for the:

CWHa1
VANCOUVER ISLAND DRIER MARITIME CWH VARIANT

TROPHOTOPE (soil nutrient regime)



① **PlFd** Ⓛ
- 1.1 *Lichen* spp.
- 1.3 *Vaccinium parvifolium*
- 1.4 *Gaultheria shallon*
- 2.1 *Holodiscus discolor*

② **Fd** (L-P)
- 1.3 *Vaccinium parvifolium*
- 1.4 *Gaultheria shallon*
- 2.1 *Holodiscus discolor*
- 2.2 *Kindbergia oregana*

③ **FdCw** Ⓟ
- 2.2 *Mahonia nervosa*
- 3.2 *Symphoricarpos hesperius*
- 3.3 *Rhytidiadelphus triquetrus*
- 3.4 *Polystichum munitum*

④ **FdCw** (P-M)
- 1.3 *Vaccinium parvifolium*
- 1.4 *Hylocomium splendens*
- 1.5 *Rhytidiadelphus loreus*
- 2.2 *Kindbergia oregana*

⑤ **FdCw** Ⓜ
- 1.4 *Hylocomium splendens*
- 2.2 *Kindbergia oregana*
- 3.3 *Pteridium aquilinum*
- 3.4 *Polystichum munitum*

⑥ **HwCw** Ⓜ
- 1.4 *Hylocomium splendens*
- 1.5 *Rhytidiadelphus loreus*
- 1.6 *Blechnum spicant*

⑦ **FdBgCw** Ⓖ
- 3.4 *Polystichum munitum*
- 3.5 *Tiarella trifoliata*
- 3.6 *Athyrium filix-femina*

⑧ **AcBgCw** Ⓖ

⑨ **PlCw** Ⓛ
- 1.6 *Spiraea douglasii*
- 1.7 *Sphagnum* spp.

⑩ **CwHw** (P-M)
- 3.6 *Athyrium filix-femina*
- 3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for the Pacific Ranges Drier Maritime CWH Variant - (CWHa2) - Grid No. 8.

General comments:

-- Lw is recommended on a trial basis as a minor crop species on dry sites

-- where recommended, Cw (as a major species) or Lw and Pw (as minor species) are alternatives to Fd on sites affected by laminated root rot

-- Ss susceptible to Sitka spruce weevil

Specific comments:

Site
Unit No.

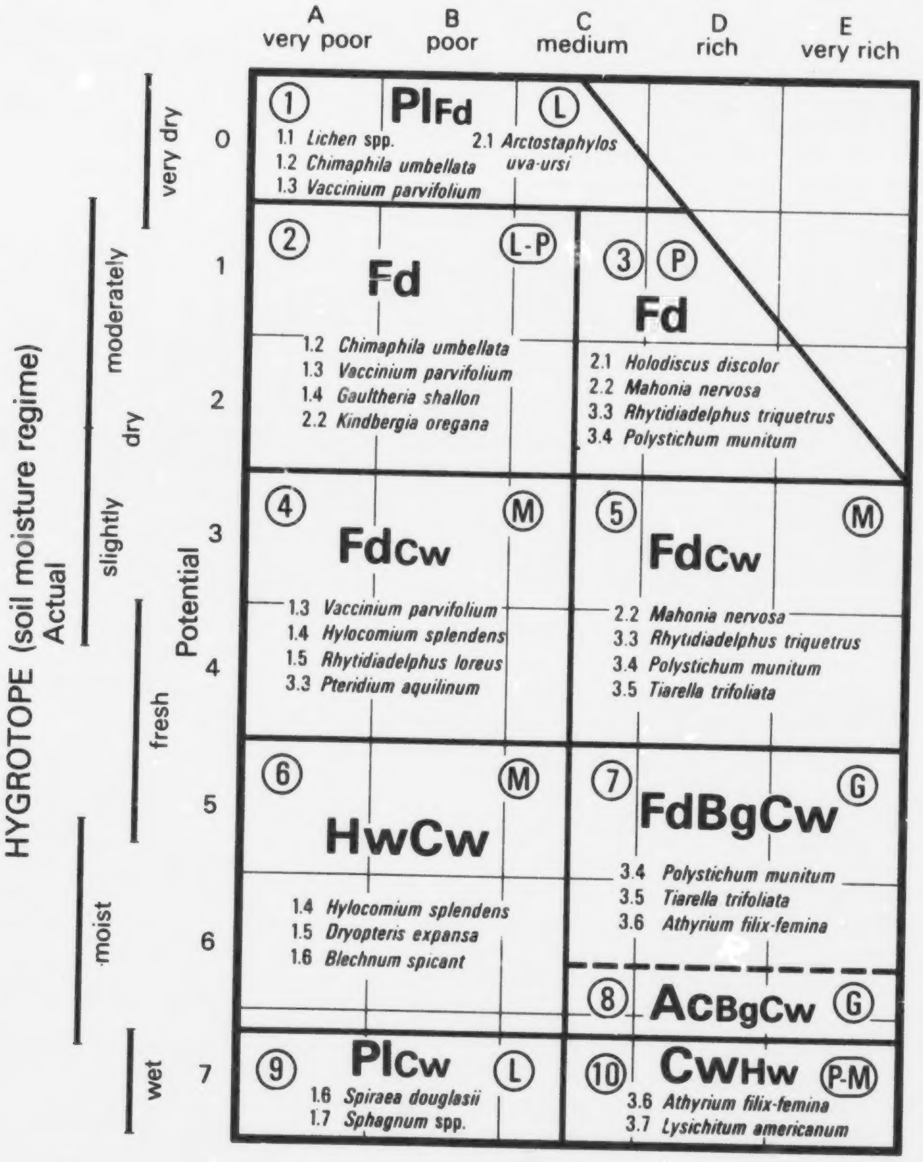
1. marginal sites for timber production
2. Cw can function as a non-crop (nurse) species to suppress a lower shrub layer of salal; Lw is an acceptable minor species
3. Lw and Pw are acceptable minor species; Cw can function as a non-crop species to suppress a lower shrub layer of salal
4. Hw is an alternative to Fd in the wettest parts of the variant; Fd-Hw mixtures, however, are not recommended - Fd should be used as a minor to Hw or Hw as a minor to Fd; inclusion of Cw is desirable to both Hw or Fd
5. Pw is an acceptable minor species
6. Fd is an acceptable minor species
7. brush hazard sites; establishment of a mixed-species-stand is desirable
8. alluvial floodplains; high brush hazard sites; Cw or Bg-Cw mixtures may be used as major species
9. marginal sites for timber production
10. brush hazard sites; Pw and Ss are acceptable minor species; Hw (regenerated naturally) is an acceptable minor species, depending on the frequency of acid organic mounds on the site

Grid No. 8

Recommended tree species for the:

CWHa2 | PACIFIC RANGES DRIER MARITIME CWH VARIANT

TROPHOTOPE (soil nutrient regime)



① **PlFd** Ⓛ
1.1 *Lichen* spp.
1.2 *Chimaphila umbellata*
1.3 *Vaccinium parvifolium*
2.1 *Arctostaphylos uva-ursi*

② **Fd** (L-P)
1.2 *Chimaphila umbellata*
1.3 *Vaccinium parvifolium*
1.4 *Gaultheria shallon*
2.2 *Kindbergia oregana*

③ Ⓟ **Fd**
2.1 *Holodiscus discolor*
2.2 *Mahonia nervosa*
3.3 *Rhytidiadelphus triquetrus*
3.4 *Polystichum munitum*

④ **FdCw** Ⓜ
1.3 *Vaccinium parvifolium*
1.4 *Hylocomium splendens*
1.5 *Rhytidiadelphus loreus*
3.3 *Pteridium aquilinum*

⑤ **FdCw** Ⓜ
2.2 *Mahonia nervosa*
3.3 *Rhytidiadelphus triquetrus*
3.4 *Polystichum munitum*
3.5 *Tiarella trifoliata*

⑥ **HwCw** Ⓜ
1.4 *Hylocomium splendens*
1.5 *Dryopteris expansa*
1.6 *Blechnum spicant*

⑦ **FdBgCw** Ⓖ
3.4 *Polystichum munitum*
3.5 *Tiarella trifoliata*
3.6 *Athyrium filix-femina*

⑧ **AcBgCw** Ⓖ

⑨ **PlCw** Ⓛ
1.6 *Spiraea douglasii*
1.7 *Sphagnum* spp.

⑩ **CwHw** (P-M)
3.6 *Athyrium filix-femina*
3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for the Windward Submontane Maritime Wetter CWH Variant (CWHb1) - Grid No. 9.

General comments:

-- the application of Fd should be restricted to the southern part of the variant (south of Brooks Peninsula or Seymour Inlet) and based on some evidence of its presence in the local area

-- there is potential for widespread application of Ss on nutrient-medium to very rich sites in the northern part of the variant (north of Brooks Peninsula or Seymour Inlet)

-- Gaultheria shallon replaces Hylocomium splendens as representative species for EISG 1.4 in site units 3 and 5 on western and northern Vancouver Island

Specific comments:

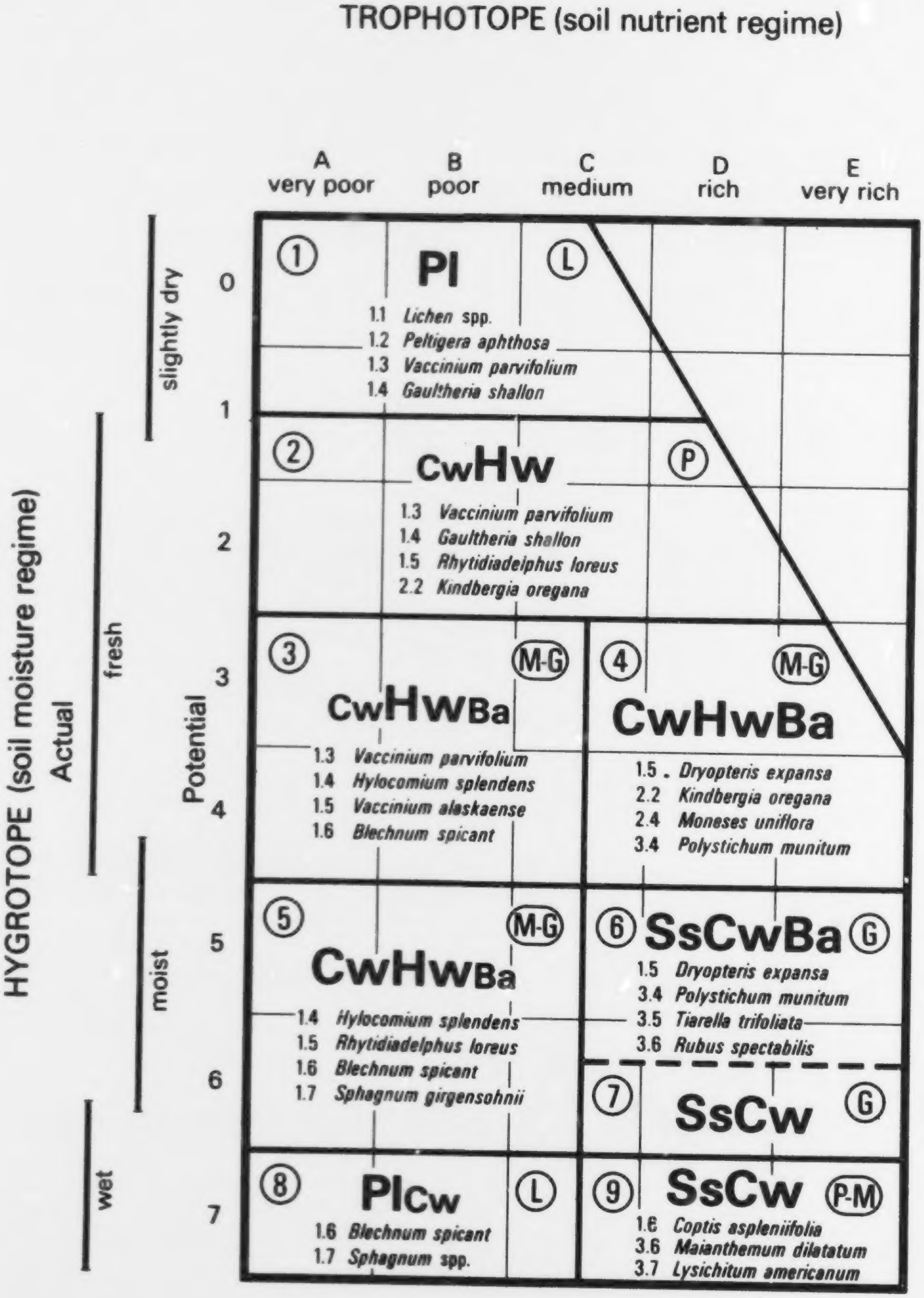
Site
Unit No.

1. marginal sites for timber production; Fd is an alternative to Pl
2. Fd is an alternative to Hw; Ss is an acceptable minor species on nutrient-medium sites
3. Ss is an acceptable major species on nutrient-medium sites
4. Fd or Ss are alternatives to Hw
5. Ss is an acceptable minor species on nutrient-medium sites; the distribution of Hw should be related to acid organic mounds
6. brush hazard sites; establishment of a mixed-species stand is desirable; Ba is an alternative to Ss or Cw; Cw is preferable on steep slopes; Hw is an acceptable minor species
7. alluvial floodplains; high brush hazard sites; establishment of a mixed-species-stand is desirable; the application of Ac as an alternative to coniferous species should be based on some evidence of its presence in the local area
8. marginal sites for timber production
9. brush hazard sites; Hw is an acceptable minor species, depending on the frequency of acid organic mounds on the site

Grid No. 9

Recommended tree species for the:

CWHb1	WINDWARD SUBMONTANE MARITIME WETTER CWH VARIANT



① Pl Ⓛ
1.1 *Lichen* spp.
1.2 *Peltigera aphthosa*
1.3 *Vaccinium parvifolium*
1.4 *Gaultheria shallon*

② CwHw Ⓟ
1.3 *Vaccinium parvifolium*
1.4 *Gaultheria shallon*
1.5 *Rhytidiadelphus loreus*
2.2 *Kindbergia oregana*

③ CwHwBa (M-G)
1.3 *Vaccinium parvifolium*
1.4 *Hylocomium splendens*
1.5 *Vaccinium alaskaense*
1.6 *Blechnum spicant*

④ CwHwBa (M-G)
1.5 *Dryopteris expansa*
2.2 *Kindbergia oregana*
2.4 *Moneses uniflora*
3.4 *Polystichum munitum*

⑤ CwHwBa (M-G)
1.4 *Hylocomium splendens*
1.5 *Rhytidiadelphus loreus*
1.6 *Blechnum spicant*
1.7 *Sphagnum girgensohnii*

⑥ SsCwBa Ⓖ
1.5 *Dryopteris expansa*
3.4 *Polystichum munitum*
3.5 *Tiarella trifoliata*
3.6 *Rubus spectabilis*

⑦ SsCw Ⓖ

⑧ PlCw Ⓛ
1.6 *Blechnum spicant*
1.7 *Sphagnum* spp.

⑨ SsCw (P-M)
1.6 *Coptis aspleniifolia*
3.6 *Maianthemum dilatatum*
3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for the Windward Montane Maritime Wetter CWH Variant (CWHb2) - Grid No. 10

General comments:

-- the application of Fd and Pw should be restricted to the southern part of the variant, based on some evidence of its presence in the local area

-- there is potential for widespread application of Ss on nutrient-medium to very rich sites in the northern part of the variant (north of Brooks Peninsula or Seymour Inlet)

-- advance natural regeneration of Ba, Hw, Cw, and Yc may provide much of the desired component of those species

-- Yc is an alternative to Cw in the upper limit of the variant

-- Bp is an alternative to Ba on nutrient-medium to very rich sites south of 50°N latitude

Specific comments:

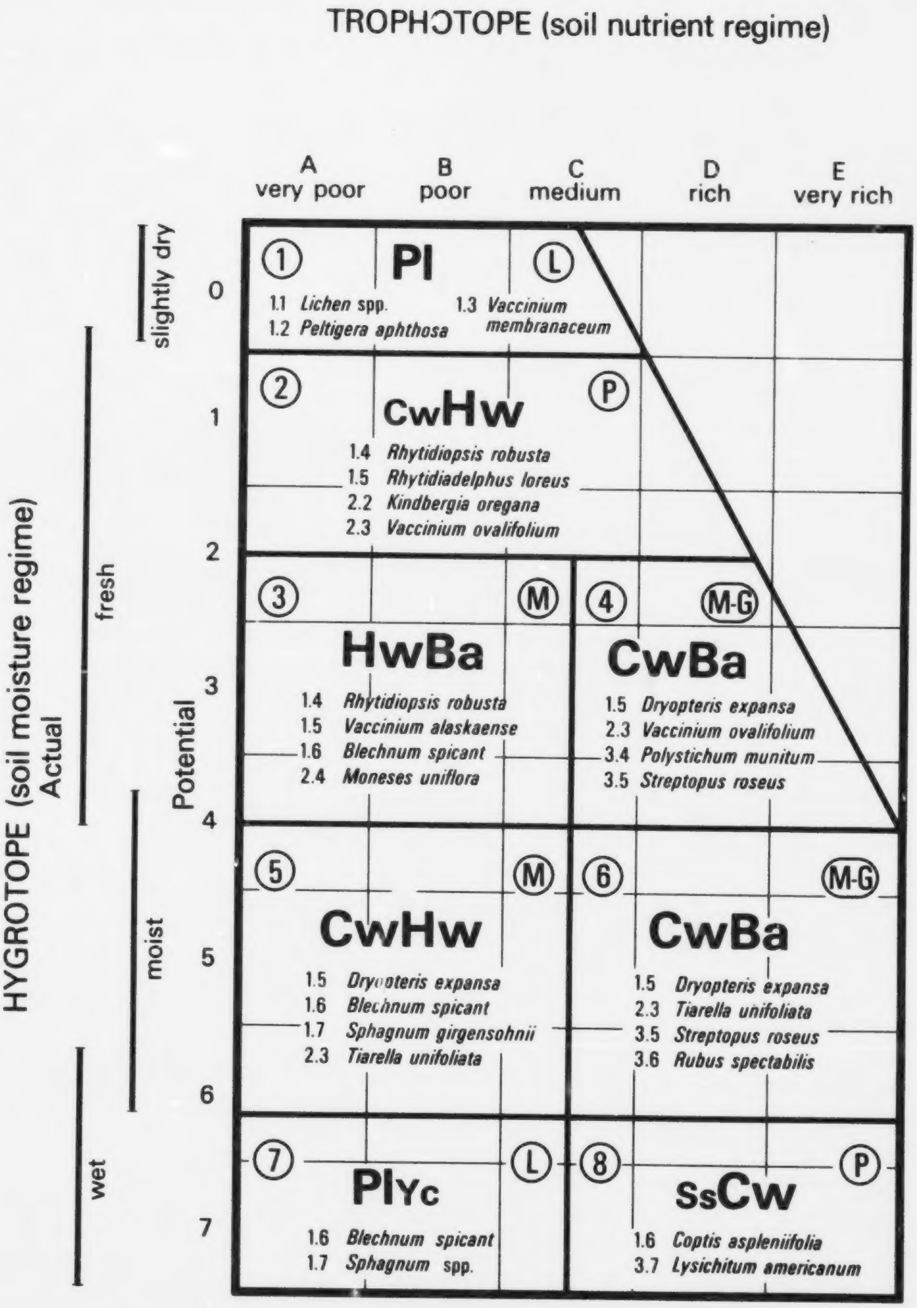
Site
Unit No.

1. marginal sites for timber production; Fd is an alternative to Pl
2. Fd is an alternative to Hw on south facing slopes; Pw or Ss are acceptable minor species on nutrient-medium sites
3. Cw is an acceptable minor species or alternative to Ba on steep slopes; Ss is an acceptable major species on nutrient-medium sites
4. Fd is an alternative to Ba on south facing slopes; Ss-Hw is an alternative to Cw-Ba; Pw is an acceptable minor species
5. Ba is an acceptable minor species or alternative to Cw; Ss is an acceptable major species on nutrient-medium sites
6. brush hazard sites; establishment of a mixed-species-stand is desirable; Ss is an acceptable minor species or alternative to Ba; Hw is an acceptable minor species
7. marginal sites for timber production
8. Hw is an acceptable minor species, depending on the frequency of acid organic mounds on the site

Grid No. 10

Recommended tree species for the:

CWHb2	**WINDWARD MONTANE MARITIME WETTER CWH VARIANT**



Comments on the Recommended Tree Species for the Leeward Submontane Maritime Wetter CWH Variant (CWHb3) - Grid No. 11.

General comments:

-- Lw is recommended on a trial basis as a minor species on dry sites

Specific comments:

Site
Unit No.

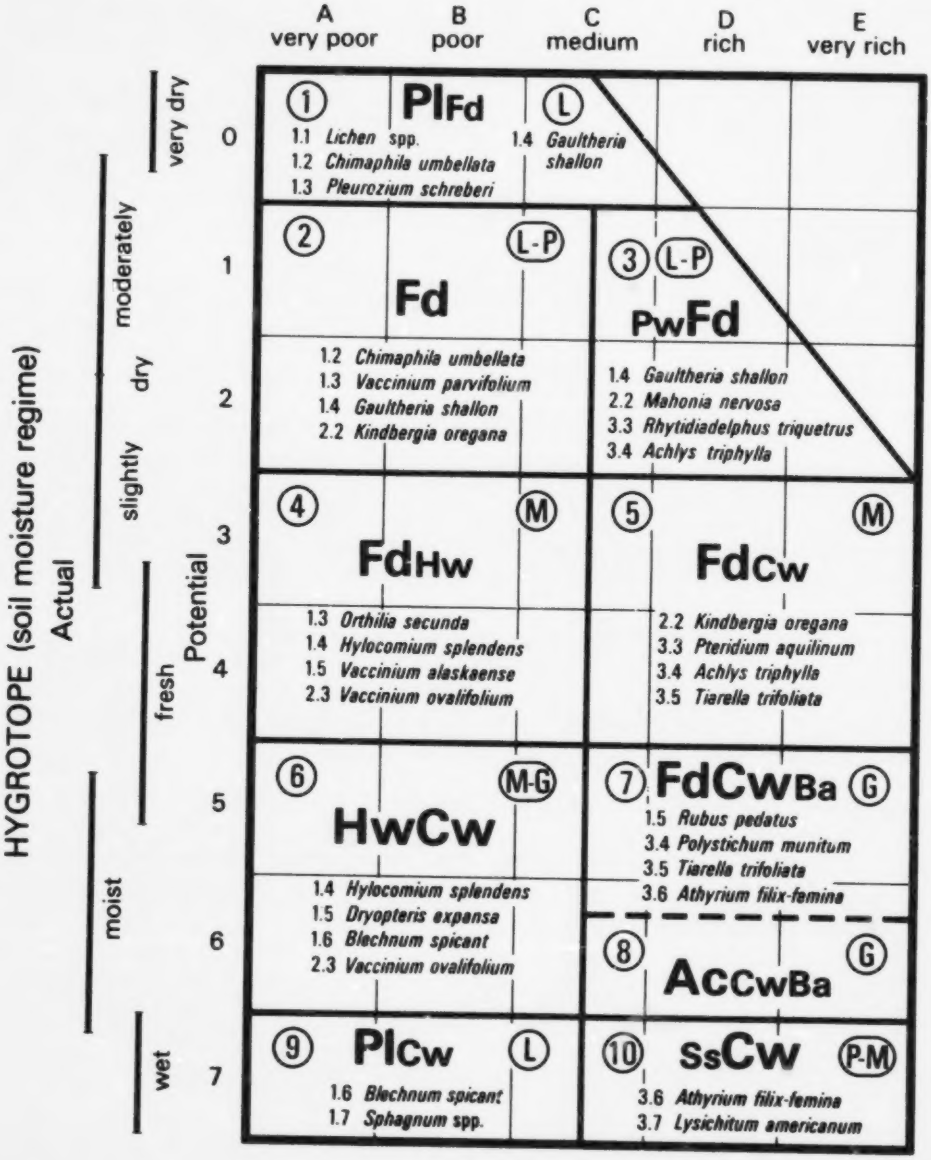
1. marginal sites for timber production
2. Cw can function as a non-crop (nurse) species to suppress a lower shrub layer of salal; Lw is an acceptable minor species
3. Lw is an alternative species to Pw; Cw is an acceptable non-crop species (cf. site unit 2)
4. Hw may be chosen as a major species and Fd may be excluded or chosen as a minor species, e.g., on fresh, north facing sites; Cw is an acceptable minor species
5. Pw and Hw are acceptable minor species
6. Ba is an acceptable minor species
7. brush hazard sites; establishment of a mixed-species-stand is desirable
8. alluvial floodplains; high brush hazard sites; Cw or Cw-Ba mixtures may be used as major species
9. marginal sites for timber production
10. brush hazard sites; Pw is an alternative to Ss; Hw is an acceptable minor species, depending on the frequency of acid organic mounds on the site

Grid No. 11

Recommended tree species for the:

CWHb3	**LEEWARD SUBMONTANE MARITIME WETTER CWH VARIANT**

TROPHOTOPE (soil nutrient regime)



Comments on the Recommended Tree Species for the Leeward Montane Maritime Wetter CWH Variant (CWHb4) - Grid No. 12.

General comments:

-- on a trial basis, Lw (as minor species) and Se and Bp are recommended as crop species

-- Yc is an alternative to Cw; however, both species can be used on the same site

-- Cw is an alternative to Ba on nutrient-very poor to medium sites or on steep slopes

Specific comments:

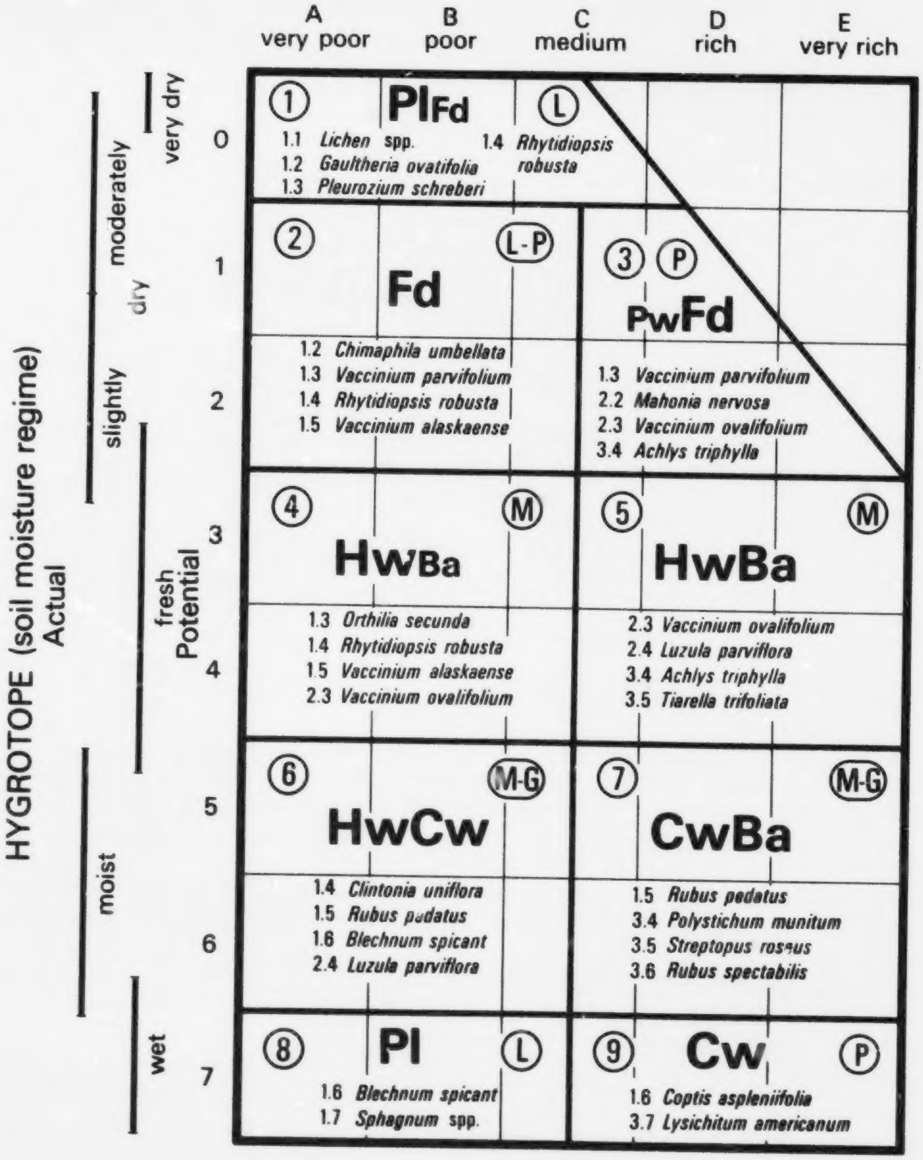
Site Unit No.	
1.	marginal sites for timber production
2.	Lw or Se are alternatives to Fd
3.	Lw or Se are alternatives to Fd
4.	Fd is an alternative to Hw on south facing slopes; Cw is an alternative to Ba; Se is an alternative to Hw
5.	establishment of a mixed-species-stand is desirable; Fd or Se are alternatives to Hw on south facing slopes; Cw is an alternative to Ba: Bp is an alternative to Ba; Pw is an acceptable minor species
6.	Bp or Ba are acceptable minor species on nutrient-medium sites
7.	brush hazard sites; establishment of a mixed-species stand is desirable; Hw is an acceptable minor species; Fd is an acceptable minor species on steep south facing slopes
8.	marginal sites for timber production
9.	brush hazard sites; Pw or Ss are alternative minor species; Hw is an acceptable minor species, depending on the frequency of acid organic mounds on the site

Grid No. 12

Recommended tree species for the:

CWHb4	LEEWARD MONTANE MARITIME WETTER CWH VARIANT

TROPHOTOPE (soil nutrient regime)



① **PlFd** Ⓛ
1.1 *Lichen* spp.
1.2 *Gaultheria ovatifolia*
1.3 *Pleurozium schreberi*
1.4 *Rhytidiopsis robusta*

② **Fd** (L-P)
1.2 *Chimaphila umbellata*
1.3 *Vaccinium parvifolium*
1.4 *Rhytidiopsis robusta*
1.5 *Vaccinium alaskaense*

③ Ⓟ **PwFd**
1.3 *Vaccinium parvifolium*
2.2 *Mahonia nervosa*
2.3 *Vaccinium ovalifolium*
3.4 *Achlys triphylla*

④ **HwBa** Ⓜ
1.3 *Orthilia secunda*
1.4 *Rhytidiopsis robusta*
1.5 *Vaccinium alaskaense*
2.3 *Vaccinium ovalifolium*

⑤ **HwBa** Ⓜ
2.3 *Vaccinium ovalifolium*
2.4 *Luzula parviflora*
3.4 *Achlys triphylla*
3.5 *Tiarella trifoliata*

⑥ **HwCw** (M-G)
1.4 *Clintonia uniflora*
1.5 *Rubus pedatus*
1.6 *Blechnum spicant*
2.4 *Luzula parviflora*

⑦ **CwBa** (M-G)
1.5 *Rubus pedatus*
3.4 *Polystichum munitum*
3.5 *Streptopus roseus*
3.6 *Rubus spectabilis*

⑧ **Pl** Ⓛ
1.6 *Blechnum spicant*
1.7 *Sphagnum* spp.

⑨ **Cw** Ⓟ
1.6 *Coptis aspleniifolia*
3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for the Southern Submaritime Wetter CWH Variant (CWHb5) - Grid No. 13.

General comments:

-- Hw and Yc are, in general, less desirable species in the eastern limits of the variant

-- Se is an alternative to, or can be used as a major species with Fd in the upper, eastern limits of the variant

-- Lw is recommended on a trial basis as a minor species in the eastern limits of the variant

-- Bg may be used as minor or major species in the western limits of the variant south of 50°N latitude

-- Bp is recommended as a minor species on nutrient-medium to very rich sites

Specific comments:

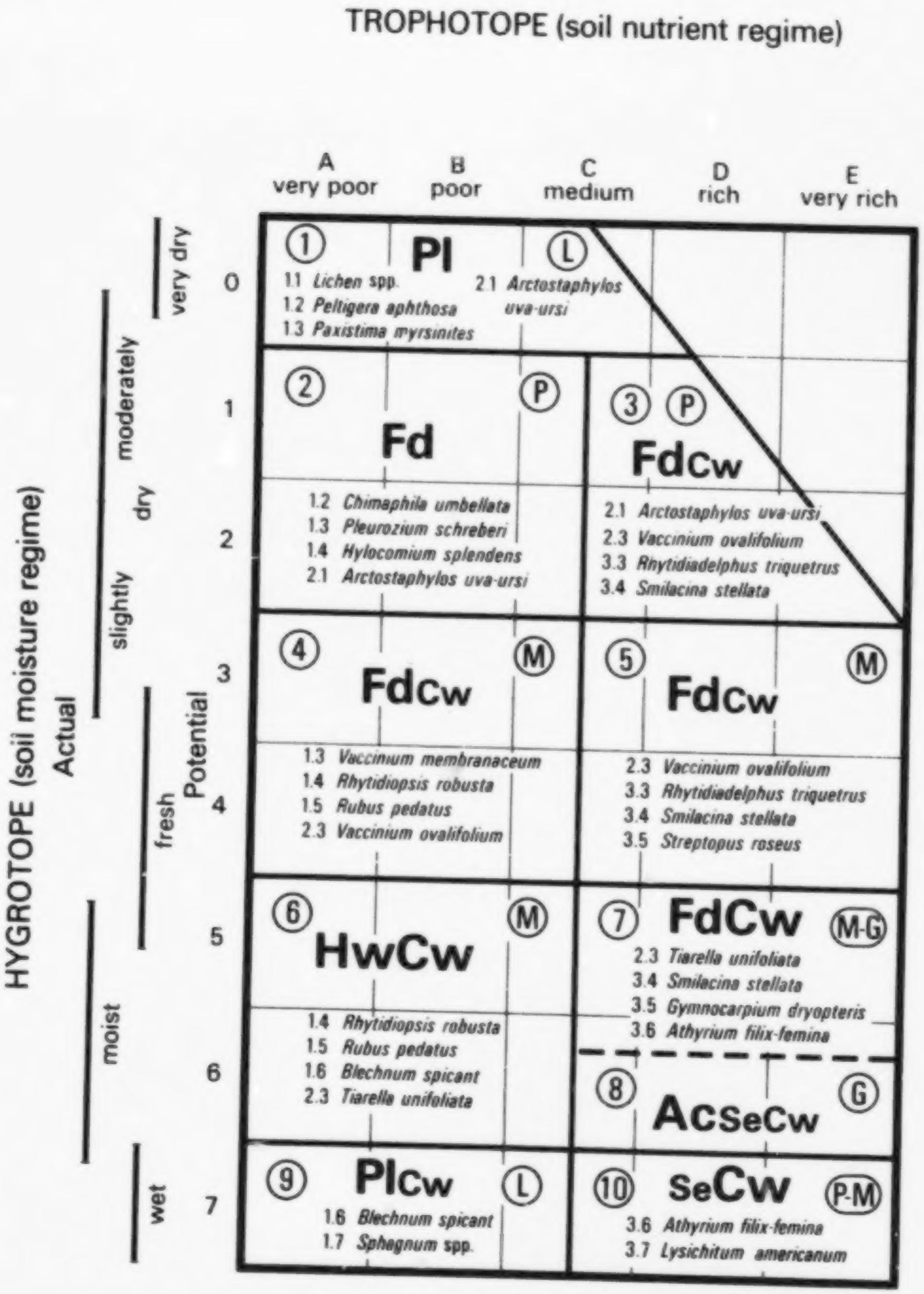
Site
Unit No.

1. marginal sites for timber production
2. Se is an alternative to Fd; Lw is an acceptable minor species
3. Lw and Pw are acceptable minor species; Se is an alternative to Fd; Cw can function as a non-crop (nurse) species
4. Se or Hw are alternatives to Fd on dry and fresh sites, respectively; Ba or Bp are alternatives to Cw
5. Lw and Pw are acceptable minor species; Se is an alternative to Fd; Ba or Bp are alternatives to Cw
6. Ba and Yc are alternatives to Cw in the upper, western limits of the variant
7. brush hazard sites; establishment of a mixed-species-stand is desirable; Se-Ba is an alternative to Fd-Cw mixture; Ba, Bg, or Bp are alternatives to Cw
8. alluvial floodplains; high brush hazard sites; Cw, Se-Cw, Se-Ba, or Cw-Ba mixtures may be used as major species
9. marginal sites for timber production
10. Yc can replace Cw in upper, western limits of the variant; Bl is an alternative to Cw; Pw is an acceptable minor species

Grid No. 13

Recommended tree species for the:

CWHb5	**SOUTHERN SUBMARITIME WETTER CWH VARIANT**



① **Pl** Ⓛ
1.1 *Lichen* spp.
1.2 *Peltigera aphthosa*
1.3 *Paxistima myrsinites*
2.1 *Arctostaphylos uva-ursi*

② **Fd** Ⓟ
1.2 *Chimaphila umbellata*
1.3 *Pleurozium schreberi*
1.4 *Hylocomium splendens*
2.1 *Arctostaphylos uva-ursi*

③ Ⓟ **FdCw**
2.1 *Arctostaphylos uva-ursi*
2.3 *Vaccinium ovalifolium*
3.3 *Rhytidiadelphus triquetrus*
3.4 *Smilacina stellata*

④ **FdCw** Ⓜ
1.3 *Vaccinium membranaceum*
1.4 *Rhytidiopsis robusta*
1.5 *Rubus pedatus*
2.3 *Vaccinium ovalifolium*

⑤ **FdCw** Ⓜ
2.3 *Vaccinium ovalifolium*
3.3 *Rhytidiadelphus triquetrus*
3.4 *Smilacina stellata*
3.5 *Streptopus roseus*

⑥ **HwCw** Ⓜ
1.4 *Rhytidiopsis robusta*
1.5 *Rubus pedatus*
1.6 *Blechnum spicant*
2.3 *Tiarella unifoliata*

⑦ **FdCw** (M-G)
2.3 *Tiarella unifoliata*
3.4 *Smilacina stellata*
3.5 *Gymnocarpium dryopteris*
3.6 *Athyrium filix-femina*

⑧ **AcSeCw** Ⓖ

⑨ **PlCw** Ⓛ
1.6 *Blechnum spicant*
1.7 *Sphagnum* spp.

⑩ **SeCw** (P-M)
3.6 *Athyrium filix-femina*
3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for Central Submaritime Lower Wetter CWH Variant (CWHb6) - Grid No. 14.

General comments:

-- Se is an alternative to Ss in the eastern and upper limits of the variant

-- Ss is susceptible to Sitka spruce weevil

-- information presented in this grid should be considered provisional due to limited data

Specific comments:

Site
Unit No.

1. marginal sites for timber production

2. Pl is an alternative to Fd

3. Pl is an alternative to Fd

4. Hw is an acceptable major species on fresh sites

5. Ba is an alternative to Fd on fresh sites, particularly on northerly aspects; Cw is more suitable on steep slopes, Ss is an acceptable minor species

6. Fd is an alternative to Hw, Ba is an acceptable minor species

7. brush hazard sites; establishment of a mixed-species-stand is desirable; Ba is an alternative to Fd, particularly on northerly aspects; Cw is more suitable on steep slopes

8. alluvial floodplains; high brush hazard sites; Cw-Ba or Cw-Ba(Ss) mixtures may be used as major species

9. marginal sites for timber production

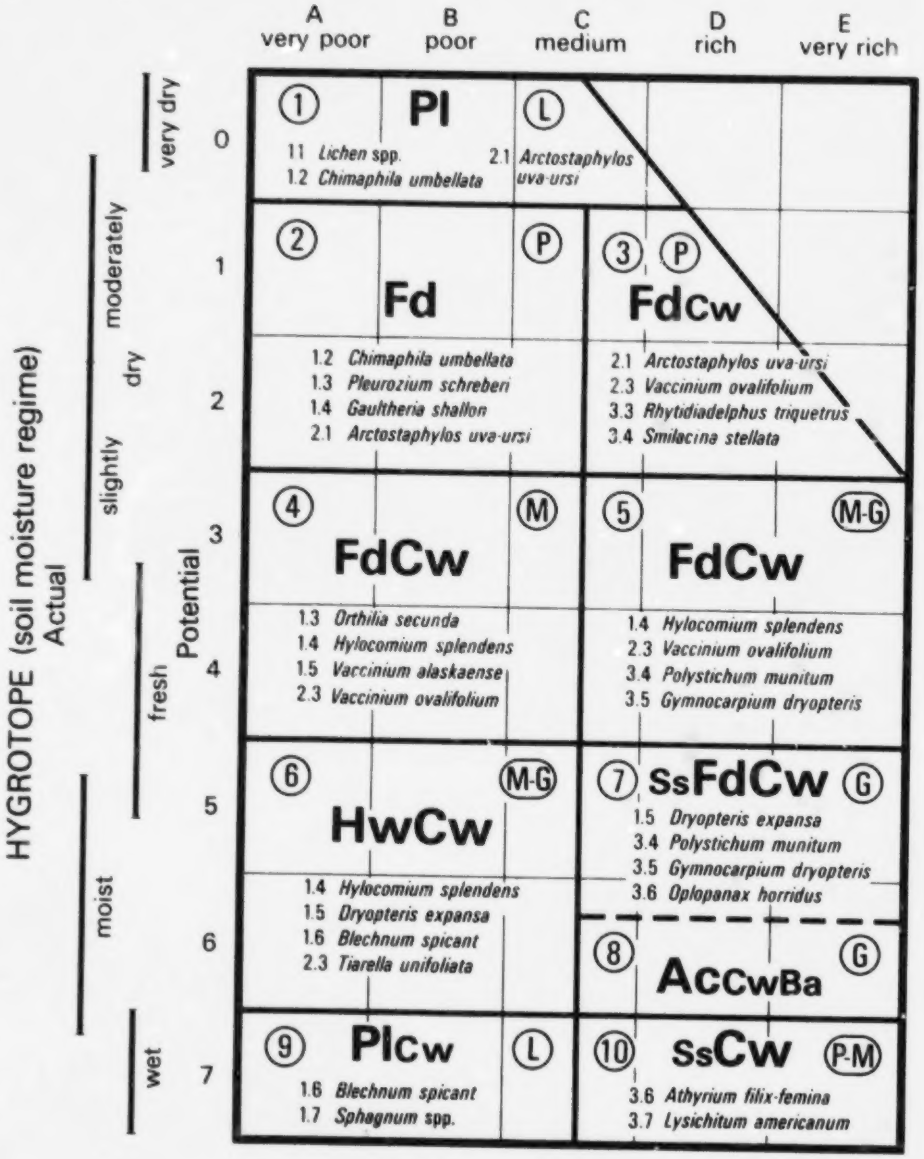
10. Hw is an alternative minor species depending on the frequency of acid organic mounds on the site

Grid No. 14

Recommended tree species for the:

CWHb6	CENTRAL SUBMARITIME LOWER WETTER CWH VARIANT

TROPHOTOPE (soil nutrient regime)



A very poor — B poor — C medium — D rich — E very rich

HYGROTOPE (soil moisture regime)

Actual: very dry; moderately dry; slightly dry; fresh; moist; wet

Potential: 0, 1, 2, 3, 4, 5, 6, 7

① **Pl** Ⓛ
1.1 *Lichen* spp.
1.2 *Chimaphila umbellata*
2.1 *Arctostaphylos uva-ursi*

② **Fd** Ⓟ
1.2 *Chimaphila umbellata*
1.3 *Pleurozium schreberi*
1.4 *Gaultheria shallon*
2.1 *Arctostaphylos uva-ursi*

③ Ⓟ **FdCw**
2.1 *Arctostaphylos uva-ursi*
2.3 *Vaccinium ovalifolium*
3.3 *Rhytidiadelphus triquetrus*
3.4 *Smilacina stellata*

④ **FdCw** Ⓜ
1.3 *Orthilia secunda*
1.4 *Hylocomium splendens*
1.5 *Vaccinium alaskaense*
2.3 *Vaccinium ovalifolium*

⑤ **FdCw** (M-G)
1.4 *Hylocomium splendens*
2.3 *Vaccinium ovalifolium*
3.4 *Polystichum munitum*
3.5 *Gymnocarpium dryopteris*

⑥ **HwCw** (M-G)
1.4 *Hylocomium splendens*
1.5 *Dryopteris expansa*
1.6 *Blechnum spicant*
2.3 *Tiarella unifoliata*

⑦ **SsFdCw** Ⓖ
1.5 *Dryopteris expansa*
3.4 *Polystichum munitum*
3.5 *Gymnocarpium dryopteris*
3.6 *Oplopanax horridus*

⑧ **AcCwBa** Ⓖ

⑨ **PlCw** Ⓛ
1.6 *Blechnum spicant*
1.7 *Sphagnum* spp.

⑩ **SsCw** (P-M)
3.6 *Athyrium filix-femina*
3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for the Central Submaritime Upper Wetter CWH Variant (CWHb7) - Grid No. 15.

General comments:

-- Bl is an alternative to Ba on sites influenced by cold air outflow from glaciers

-- the application of Fd should be based on some evidence of its presence in the local area

-- Yc is an alternative to Cw, particularly in upper ranges of the variant

-- information presented in this grid should be considered provisional due to limited data

Specific comments:

Site
Unit No.

1. marginal sites for timber production

2. Fd or Se are alternatives to Hw

3. Fd is an alternative to Se; Bl is an alternative to Cw in upper ranges of the variant and on sites influenced by cold air drainage; Hw is an acceptable minor species

4. Se is an alternative to Hw on nutrient-medium sites; Cw or Yc (upper elevations) are alternatives to Ba on steep slopes; Fd-Cw is an alternative to Se-Ba at lower elevations; Hw is an acceptable minor species

6. Ba is an alternative major species

7. brush hazard sites; establishment of a mixed-species-stand is desirable; Cw or Yc (uppe elevations) are alternatives to Ba on steep lopes

8. alluvial floodplains; high brush hazard sites; establishment of mixed-species-stand is desirable; Ac is an alternative to coniferous mixtures

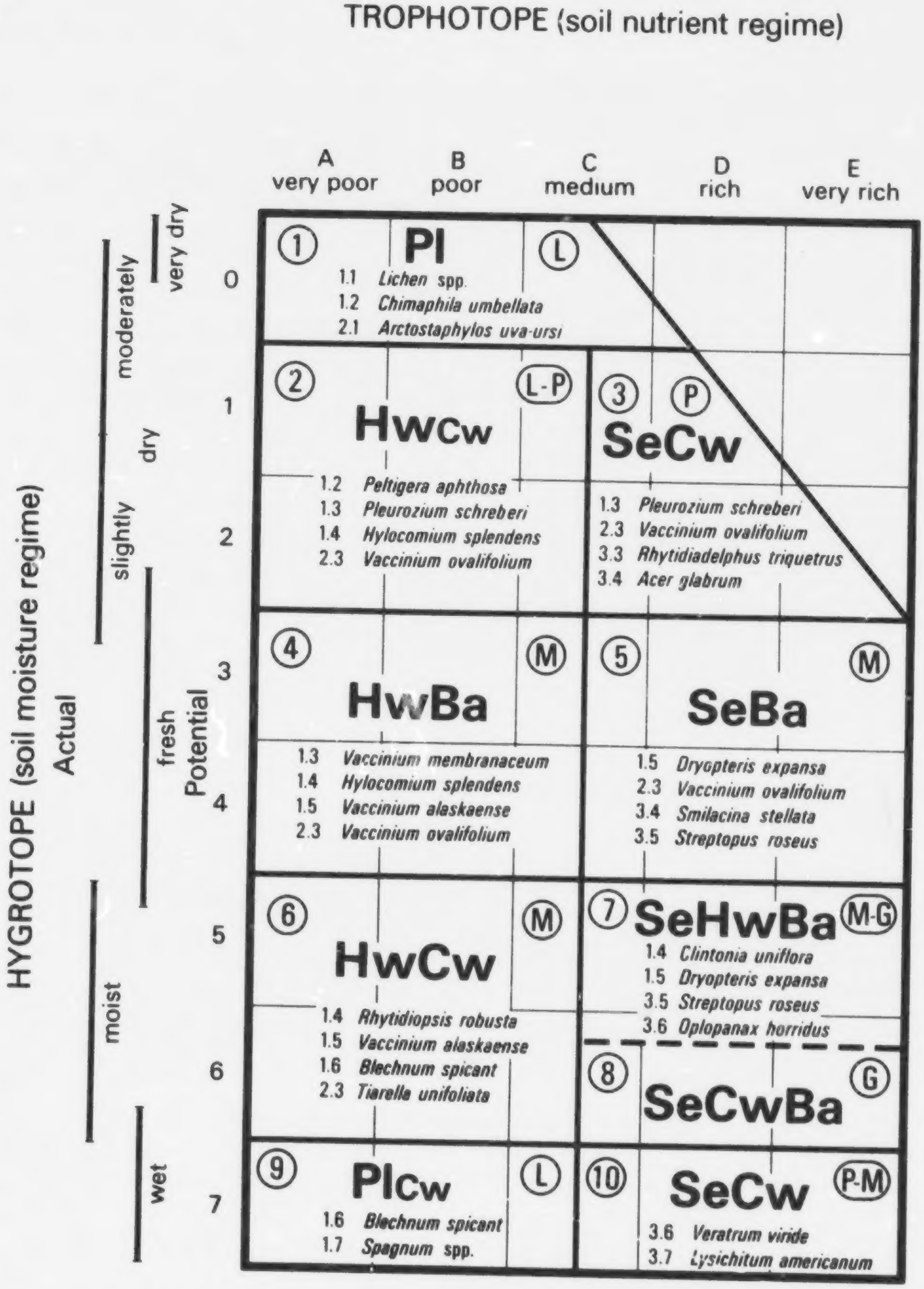
9. marginal sites for timber production

10. Hw is an alternative minor species, depending on the frequency of acid organic mounds on the site

Grid No. 15

Recommended tree species for the:

CWHb7	CENTRAL SUBMARITIME UPPER WETTER CWH VARIANT



Comments on the Recommended Tree Species for the Southern Drier Submaritime CWH Variant (CWHc1) - Grid No. 16.

General comments:

-- Hw is, in general, a less desirable crop species

-- Bp, Lw, and Py are recommended as minor species on a trial basis in the eastern limits of the variant

-- Bg should only be applied south of 50°N latitude

Specific comments:

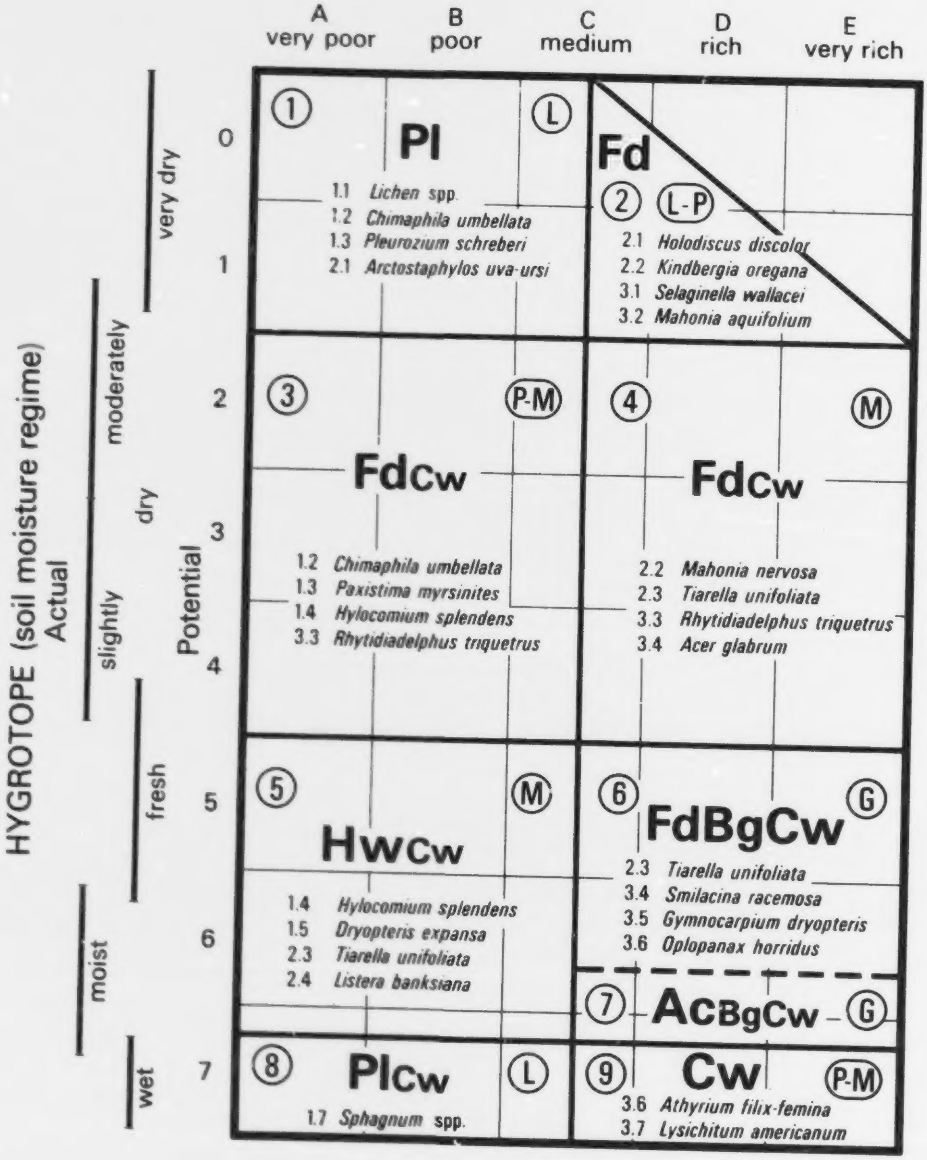
Site
Unit No.

1. marginal sites for timber production
2. Py is an alternative to Fd
3. Pl is an alternative to Fd on moderately dry sites; Lw is an acceptable minor species
4. brush hazard sites; Se is an alternative to Fd in the upper limits of the variant; Bp or Pw are alternatives to Cw in the upper limits of the subzone on slightly dry to fresh sites; Lw or Py are acceptable minor species on moderately dry sites
5. Fd is an alternative to Hw in the eastern limits of the variant
6. brush hazard sites; establishment of a mixed-species-stand is desirable; Bp is an alternative to Bg in the upper limits of the subzone
7. alluvial floodplains; high brush hazard sites; Cw or Bg-Cw mixtures are alternatives to Ac
8. marginal sites for timber production
9. brush hazard sites

Grid No. 16

Recommended tree species for the:

CWHc1	SOUTHERN DRIER SUBMARITIME CWH VARIANT



Comments on the Recommended Tree Species for the Central Drier Submaritime CWH Variant (CWHc2) - Grid No. 17.

General comments:

-- Se may be more suitable than Ss in the eastern, upper limits of the variant

-- Ss susceptible to Sitka spruce weevil

-- information presented in this grid should be considered provisional due to limited data

Specific Comments:

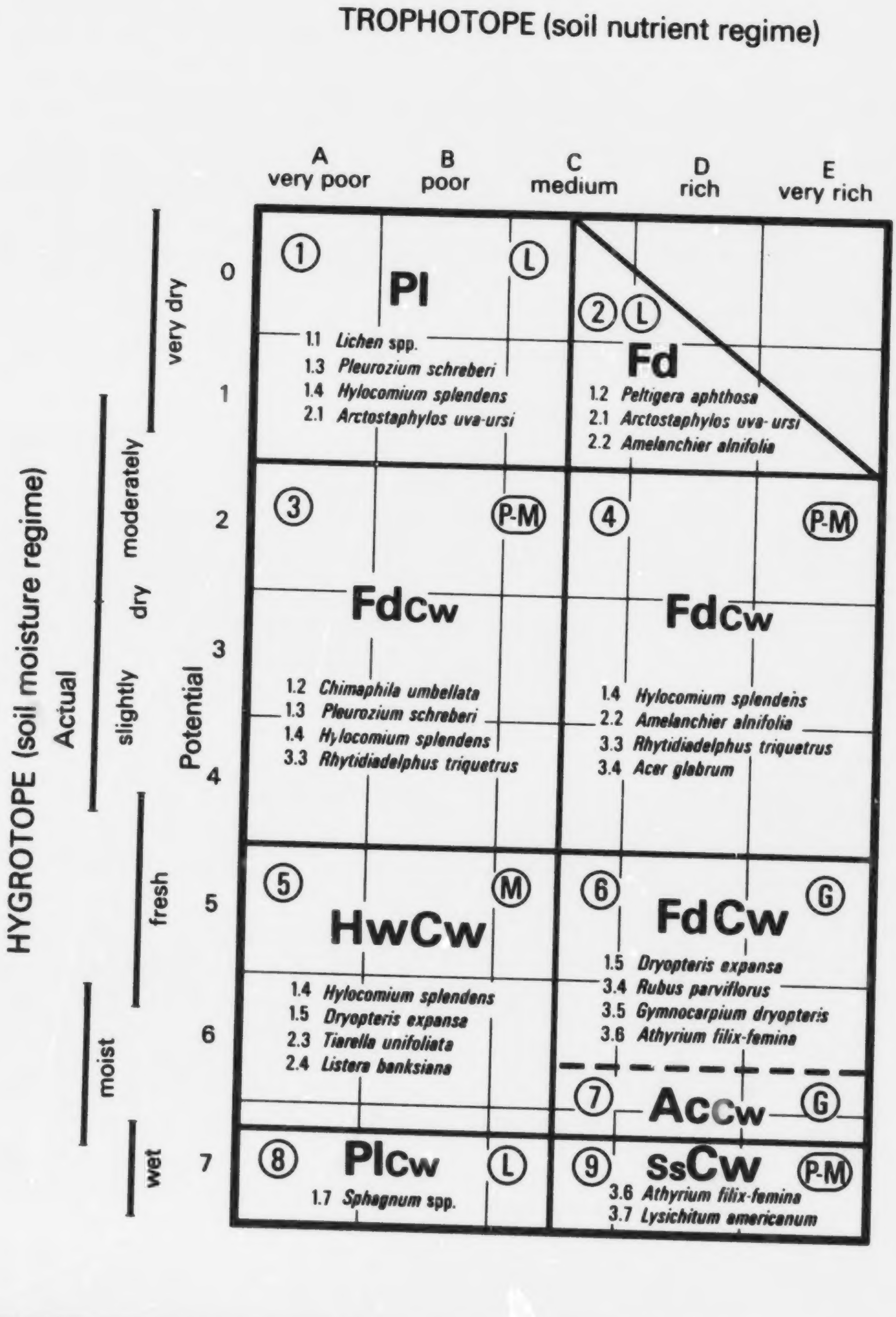
Site
Unit No.

1. marginal sites for timber production
2. Pl is an alternative to Fd
3. Pl is an alternative to Fd on moderately dry sites
4. Pl is an alternative to Fd on moderately dry sites, Ss is an alternative minor species
5. Fd is an alternative to Hw
6. brush hazard sites; establishment of a mixed-species-stand is desirable; Ss is an alternative major species
7. alluvial floodplains; high brush hazard sites; Cw (with Ss as a minor species) may be used as major species
8. marginal sites for timber production
9. brush hazard sites

Grid No. 17

Recommended tree species for the:

CWHc2	**CENTRAL DRIER SUBMARITIME CWH VARIANT**



① Pl (L)
1.1 *Lichen* spp.
1.3 *Pleurozium schreberi*
1.4 *Hylocomium splendens*
2.1 *Arctostaphylos uva-ursi*

② (L) Fd
1.2 *Peltigera aphthosa*
2.1 *Arctostaphylos uva-ursi*
2.2 *Amelanchier alnifolia*

③ (P-M) Fdcw
1.2 *Chimaphila umbellata*
1.3 *Pleurozium schreberi*
1.4 *Hylocomium splendens*
3.3 *Rhytidiadelphus triquetrus*

④ (P-M) Fdcw
1.4 *Hylocomium splendens*
2.2 *Amelanchier alnifolia*
3.3 *Rhytidiadelphus triquetrus*
3.4 *Acer glabrum*

⑤ (M) HwCw
1.4 *Hylocomium splendens*
1.5 *Dryopteris expansa*
2.3 *Tiarella unifoliata*
2.4 *Listera banksiana*

⑥ (G) FdCw
1.5 *Dryopteris expansa*
3.4 *Rubus parviflorus*
3.5 *Gymnocarpium dryopteris*
3.6 *Athyrium filix-femina*

⑦ Accw (G)

⑧ Plcw (L)
1.7 *Sphagnum* spp.

⑨ SsCw (P-M)
3.6 *Athyrium filix-femina*
3.7 *Lysichitum americanum*

Comments on the Recommended Tree Species for the Hypermaritime CWH Subzone (CWHd) - Grid No. 18.

General comments:

-- due to the unique combination of climate, topography, parent materials, and history, the ecosystems found in this subzone feature (a) predominantly site units 2, 3, 5, and 7 and (b) climax conditions of vegetation development

-- in the CWHd1 Variant, more or less limited to a narrow belt of lowlands along the outer coast of Vancouver Island (approximately 1-5 km wide, and reaching to 150 m in elevation), Ss can be used as a major species on fresh to moist and nutrient-medium sites that are under the combined influence of ocean spray and fog

-- the application of Fd in the CWHd1 Variant should be based on some evidence of its presence in the local area

Specific comments:

Site
Unit No.

1. marginal sites for timber production

2. nutrient-very poor sites are marginally suitable for timber production; Pl is an alternative to Hw on nutrient-very poor sites; Ss is an alternative to Cw on nutrient-medium sites

3. nutrient-very poor sites are marginally suitable for timber production; Pl is an alternative to Hw on nutrient-very poor sites; Ss is an alternative to Cw on nutrient-medium sites; Ba is an acceptable minor species or an alternative to Cw

4. brush hazard sites; establishment of a mixed-species stand is desirable. Yc is an alternative to Cw in the upper limits of the CWHd2 Variant; Cw or Yc are preferable on steep slopes; Hw is an acceptable minor species; Fd or Ba may be used as major species in the CWHd1 Variant

5. Pl is an alternative to Cw in the CWHd2 Variant; Hw is an acceptable minor species

6. brush hazard sites; establishment of a mixed-species stand is desirable; Ba or Yc are alternatives in the upper limits of the CWHd2 Variant; Cw or Yc are preferable on steep slopes; Hw is an acceptable minor crop species; Ba is an alternative major species in the CWHd1 Variant

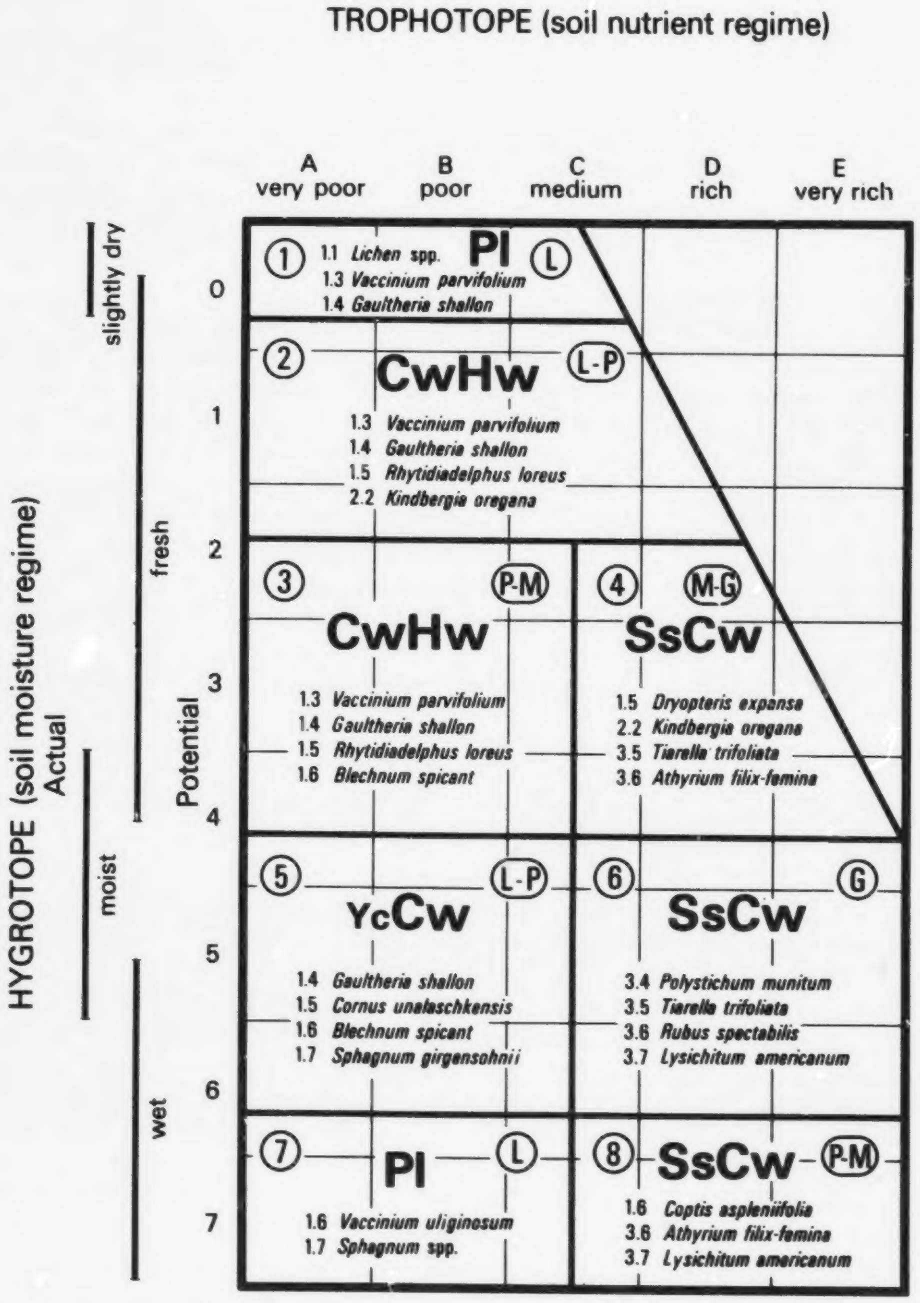
7. marginal sites for timber production

8. brush hazard sites; Hw is an acceptable minor species, depending on the frequency of acid organic mounds on the site

Grid No. 18

Recommended tree species for the:

CWHd	**HYPERMARITIME CWH SUBZONE**



4. SLASHBURNING GUIDELINES

4.1 Synopsis

A new approach to making burning prescriptions has been adopted. Rather than attempt to recommend burning prescriptions for different forest sites, we present a framework for making ecologically sound slashburning decisions. In order to assess the ecological effects of fire, a major step in this framework, a classification of the sensitivity of forest sites to fire is provided. Using this approach, a person should arrive at a decision about slashburning which meets both ecological and management requirements. Site- or area-specific burning prescriptions can then be developed by consulting the manual for prescribed broadcast burning in the Vancouver Forest Region[1].

4.2 Approach to Making Slashburning Decisions

In a literature review of the ecological effects of slashburning, Feller (1982) concluded that (a) different forest ecosystems will respond to a given slashburning treatment in different ways, depending on the characteristics of the ecosystem, and (b) the effects of slashburning on a given ecosystem will vary according to climatic conditions prior to, during, and after burning, and the intensity of the burn. This response may be positive or negative from the manager's viewpoint. In consideration of these conclusions, the approach to slashburning decision-making adopted in the Vancouver Forest Region is based on three factors:

(a) ecological factors - the ecological characteristics of forest sites,

(b) management factors - the strategy and objective of forest management,

(c) ecological effects of slashburning on site productivity and regeneration of selected tree species.

4.2.1 Ecological Factors

An ecosystem-specific approach to slashburning, as well as to other forestry practices, has been adopted in British Columbia. This is necessary because knowledge of the forest environment, the ecological characteristics of forest trees, and the influence of environmental factors on forest growth, will allow us to select the most appropriate treatments for different sites and management objectives (e.g., Daubenmire 1976; Klinka and Feller 1983; Krajina 1960, 1972; Pfister and Arno 1980). The first step in the decision-making process is, therefore, to identify and diagnose the component sites of a given area.

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[1] Op. cit., page 1.

4.2.2 Management Factors

The second step in the decision-making process is to determine, from the forest management perspective, the site preparation needs. At this stage the ecologically and economically viable alternatives to slashburning should be evaluated to determine the treatment(s) which could best meet management requirements.

Following a logging operation, removal of part of the debris, reduction of the organic materials in the forest floor, or, on some sites, control of rapidly growing weed species are often necessary for a variety of reasons. This can be accomplished by a number of management practices, slashburning being but one of them. In some situations, alternative methods to slashburning, such as burying, crushing, chipping or clearing of slash have been found to be both economically and practically feasible (Feller 1982).

To avoid ambiguity when assessing the usefulness of slashburning and alternative treatments for site preparation, the strategy of forest management must be defined. For the management intent of timber production, we adopted the yield strategy proposed by Silen (1982). In relation to slashburning this strategy requires that:

(a) in the long-term, soil fertility must be maintained or improved, not degraded,

(b) the site must be fully occupied by the growing crop, and

(c) when practical and feasible, growth constraints should be relieved to enhance the inherent site potential for growing the timber crop.

4.2.3 Ecological Effects of Slashburning

The third step in the decision-making process is to assess the potential effects of slashburning on the site(s), and on regeneration of the tree species selected for the site(s), bearing in mind that these effects will vary according to climatic conditions prior to, during, and after burning, and the intensity of the burn.

The effects of slashburning on the soil, plant regeneration, wildlife, aquatic ecosystems, and the atmosphere have been reviewed by Feller (1982). All these effects should be considered depending on how relevant they may be to the area. The effects on the soil and forest regeneration are of major significance for those areas, however, for which timber production is the management intent.

Successive harvesting that features more complete utilization and shorter rotations of timber crops will always cause depletion and removal of nutrients and organic matter from the soil. This may be aggravated further by site preparation practices, including slashburning. The decrease of soil organic matter has been correlated with deteriorating soil structure (aeration) and decreasing soil macronutrients (nitrogen, phosphorus, sulphur, potassium), and possibly micronutrients (e.g., Baker 1977; Ballard 1980; Farrell et al. 1981; Pelisek 1975; and Squire and Flinn 1981). Resulting losses of soil nutrients and organic matter may have long-term cumulative effects of reducing site productivity.

Consequently, the decision whether or not to burn a given area should consider the long-term impact of fire on site productivity. There are, however, some opportunities to conserve or add to the nutrient reserve of a site through selection of tree species, genotypes, and the use of plants living in symbiosis with nitrogen-fixing organisms (DeBell 1981). This, in conjunction with other aspects of nutrient management, may help to overcome the adverse aspects of harvesting and slashburning and sustain forest productivity levels.

The influence of slashburning on forest regeneration depends partly on its effect on the soil and partly on the particular tree species whose regeneration is desired. The response of a tree species to slashburning will vary according to the site in which that species is growing. In addition, by removing surface organic matter and living plants, and by exposing the mineral soil surface, slashburning will usually convert a site to an early seral stage. This will favour the establishment and growth of shade-intolerant tree species and may have adverse effects on the establishment and growth of those species that are shade-tolerant or shade-requiring.

A summary of the tolerance to shade and general impact of slashburning on the tree species used in forest regeneration in the Vancouver Forest Region is given in Table 18.

TABLE 18. Summary of the likely regeneration and early growth responses to slashburning of the major tree species on sites in the Vancouver Forest Region (from Feller 1982)

Tree species	Tolerance to shade[1]	Response to slashburning
Abies amabilis	very shade-tolerant to shade-tolerant	adverse on dry to fresh/nutrient-poor sites, beneficial on others
Abies grandis	moderately shade-tolerant to shade-tolerant	insufficient information available
Abies lasiocarpa	very shade-tolerant to shade-intolerant	adverse on dry to fresh/nutrient-poor sites, beneficial on others
Chamaecyparis nootkatensis	shade-tolerant to shade-intolerant	insufficient information available
Larix occidentalis	very shade-intolerant	generally beneficial except for severe burns
Picea engelmannii	moderately shade-tolerant to shade-intolerant	variable effects depending on site properties and degree of forest floor removal
Picea sitchensis	moderately shade-tolerant to shade-intolerant	generally beneficial
Pinus contorta	shade-intolerant to very shade-intolerant	generally beneficial except severe burns
Pinus monticola	shade-intolerant to very shade-intolerant	adverse on very dry sites, beneficial on others
Pinus ponderosa	shade-intolerant to very shade-intolerant	generally beneficial except on very dry sites
Pseudotsuga menziesii	moderately shade-tolerant to very shade-intolerant	adverse on dry/nutrient-poor sites, beneficial on others except for severe burns
Thuja plicata	shade-tolerant to moderately shade-tolerant	adverse on all but the wetter sites
Tsuga heterophylla	shade tolerant to moderately shade-tolerant	generally adverse, except in perhumid climates
Tsuga mertensiana	shade-tolerant to moderately shade-tolerant	insufficient information available

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[1] On some sites the very shade-tolerant or shade-tolerant class may be interpreted as a shade-requiring class.

Handley (1983)[1] proposed an interpretive classification of site sensitivity to fire, integrating the ecological characteristics of a given site with the ecological effects of fire. To facilitate the task of predicting the potential impact of fire on different sites, we have adopted and amended this classification.

Five sensitivity classes are recognized: very high, high, medium, low, and very low (Tables 19, 20, 21, 22, and 23). A key to the identification of sensitivity classes (Figure 34 and Table 24) is based on a few selected environmental properties which are determined during the site diagnosis procedure.

Characteristic environmental and vegetation features, and potential impacts of fire are described for each class. Rationale used to arrive at a particular interpretation on the impacts of fire is also given. The information for making these interpretations was obtained from Krajina (1969), B.C. Ministry of Forests regional ecosystem studies, Feller (1982), and recommendations made by a number of silvicultural and forest protection workers in southwestern British Columbia. Because of the inadequate knowledge on the ecological effects of fire, these interpretations must be regarded as approximations open to future amendments.

4.3 Making the Slashburning Decision

A flowchart indicating steps leading to a slashburning prescription is shown in Figure 35. Following site diagnosis of the area, the major factors to consider are the site preparation needs, the selection of viable options, the sensitivity of the site to fire, and the impact of fire on the selected tree species. The decision to burn or not will depend on whether the slashburning treatment a) can be implemented in relation to the climatic characteristics of a given area, b) will have minimal negative impact on site productivity and regeneration of the selected species of all the the viable options, c) will be cost-effective, and d) will be socially acceptable. Providing the slashburning treatment will meet these requirements, and is judged to be the most effective alternative, then the decision should be made to carry out the treatment. This decision, however, is fraught with difficulties because of uncertainties in defining and obtaining the climatic conditions required for the burn and in understanding and predicting the impact of slashburning on different sites.

Site- or area-specific slashburning prescriptions and their required climatic indices can be determined using a manual for prescribed burning in the Vancouver Forest Region.

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[1] Handley, D.L. 1983. Fire/site sensitivity rating. MacMillan Bloedel Ltd., Nanaimo, B.C. 6p. (mimeographed note).

TABLE 19. Characterization of the very high sensitivity class

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Characteristic features:

- very shallow (25 cm) organic or mineral soils on rock outcrops and adjacent slopes (usually 50%) or
- fragmental or highly skeletal organic or mineral soils (content of coarse fragments in the surface soil layer >80%)

Very high sensitivity class sites occur irrespective of climate and thus are found in all biogeoclimatic units. These sites are usually marginally productive, however, in perhumid climates, such as in the CWHb Subzone, the potential site productivity may be as high as medium.

Potential impact of fire:

Fire is likely to result in severe soil degradation and reduce regeneration options.

Fire will consume much of the forest floor on very high sensitivity sites. The forest floor accounts for the bulk of the soil water holding capacity and nutrient reserve. Destruction of the soil organic layer exposes the underlying mineral soil to erosion, or the underlying bedrock or coarse fragments. After fire, regeneration would proceed very slowly.

Comments:

The decision whether or not to burn a setting comprised of a significant proportion of very high sensitivity sites (>15% of the area) should be done in consultation with the District Manager.

TABLE 20. Characterization of the high sensitivity class

Characteristic features:

- very dry to fresh, nutrient-very poor to poor soils that have the following features:

1. on 50-80% slopes:
    - forest floor is ≤ 20 Mor humus form and Ae horizon is well developed (> 2 cm), or
    - soil particle site is coarse, or
    - soil is < 50 cm.

2. on < 33% slopes:
    - soil organic matter content is low (< 5%), Ae horizon is well developed (> 2 cm), soil particle site is coarse, and soil is shallow (< 50 cm).

- all other sites where a combination of high precipitation intensity and high intrinsic erodibility of the soil (e.g., a combination of low aggregate stability, steep slope, high silt-size particle content, low organic matter content, and parent materials derived from acid igneous rocks) predisposes soils to erosion. The slope gradient is the most influential factor in this respect; thus, sites located on slopes >80% should be considered potentially highly sensitive.

High sensitivity class sites occur irrespective of climate and thus are found in all biogeoclimatic units. These sites generally have a low to medium production potential. Growth constraining factors are a growing season water deficit and/or very low soil nutrient content, particularly of nitrogen.

Potential impact of fire:

Removal of the protective vegetative cover and forest floor by all but low intensity fire is likely to have a high impact on the soil.

Lesser vegetative cover and/or the forest floor are important to maintain site productivity. Fire is likely to result in highly undesirable rates of surface soil erosion, decrease of the moisture holding capacity in the surface soil, and/or decrease of the soil nutrient content; therefore, organic materials should be preserved on high sensitivity sites.

Comments:

To burn a setting comprised of a significant proportion of high sensitivity sites (e.g. > 30% of the area), a stringently controlled, low intensity surface burn should be carried out.

TABLE 21. Characterization of the medium sensitivity class

Characteristic features:

- shallow to moderately deep (25-100 cm), dry to moist, nutrient-poor to medium soils that have the following features:
    - forest floor is ≤ 20 cm thick and
    - soil organic matter content is high (> 5%) and Ae horizon is well developed (> 2 cm) or
    - soil organic matter content is low (< 5%), Ae horizon is absent or poorly developed (< 2 cm), soil particle size is not coarse, and soil is not shallow (> 50 cm)
- all other sites where a combination of high precipitation intensity and high intrinsic erodibility of the soil (cf. Table 2) predisposes soils to erosion. Sites located on slopes with gradient between 50 and 80% or those with the silty-textured soil on slopes with gradient between 33 and 50% are classified as having medium sensitivity.

Medium sensitivity class sites occur irrespective of climate and thus are found in all biogeoclimatic units. These sites have low to medium production potential. Growth constraining factors are a growing season water deficit and/or low soil nutrient content, particularly of nitrogen.

Potential impact of fire:

Fire has a potentially moderate impact on the soil. Preservation of the bulk of the forest floor is important to maintain long-term site productivity.

The rationale for this definition is similar to that given for the high sensitivity class sites. While the potential impact of fire on those is high, the impact on medium sensitivity class sites is potentially moderate, due to a combination of properties providing for a more fire resilient site.

Comments:

To burn a setting comprised predominantly of medium sensitivity sites, a controlled burn should be carried out so as to preserve the bulk of the forest floor.

TABLE 22. Characterization of the low sensitivity class

Characteristic features:

- moderately deep to deep (>50 cm), fresh to wet, nutrient-medium to very rich soils that have the following features:
  - slope is < 50%
  - soil is affected by seepage water, water table, gleying or periodic flooding, or
  - humus form is Mull or Moder (with Ah horizon) and soil particle size is coarse, or
  - forest floor is moist and thick (> 20 cm), or
  - forest floor is thin but soil organic matter content is high (> 5%)

Low sensitivity class sites are typically found in maritime perhumid, mesothermal (wetter subzones of the CWH Zone) or subalpine-boreal climates. These sites have a moderate to high production potential, which may not be reflected by the present tree species because of a less intensive nutrient cycle.

Potential impact of fire:

Fire, unless of high intensity, has a potentially low impact on the soil.

Under the prevailing climatic conditions fire removes only a small fraction of the forest floor. This loss in relation to the total depth of forest floor and/or to the quantity of organic matter in the mineral soil is considered to have a low impact on site productivity.

Comments:

Burning is an effective treatment to reduce slash, retard growth of existing ericaceous shrubs, or suppress development of other competing vegetation, and to initiate more rapid decomposition of acid Mor humus forms. However, in the case of old growth (climax) stands, such as those on West or North Vancouver Island, burning alone may not restore the growth potential.

TABLE 23. Characterization of the very low sensitivity class

Characteristic features:

- mesothermal or temperate climates, found mainly in the IDF, CDF, and CWH Zones

- moderately deep to deep (>50 cm), fresh to moist, nutrient-medium to very rich soils that have a combination of the following features:
  - forest floor is thin and humus form is a friable Moder or Mull with a well developed Ah horizon,
  - soil particle size is not coarse,
  - slope gradient is < 33%, and
  - soil is affected by seepage water, water table, gleying or periodic flooding (but these may be absent).

Very low sensitivity sites are the most productive sites for timber production in the region.

Potential impact of fire:

Fire, even if high intensity, has an insignificant impact on the soil.

The bulk of soil water holding capacity and nutrient reserve is contained in the mineral soil. Decomposition and humification of surface organic materials take place rapidly due to the active populations of soil fauna and flora. Organic matter is incorporated into the upper mineral soil layer. Destruction of the thin forest floor is not likely to affect the production potential of very low sensitivity sites; in contrast, it facilitates forest regeneration.

Comments:

Burning is an effective treatment to reduce slash and to temporarily suppress shrub competition providing it precedes development of the shrub layer.

TABLE 24. Key to the identification of site sensitivity classes - part 1

This key was developed to aid field staff in the Vancouver Forest Region in the identification of site sensitivity classes to fire. These classes indicate the potential impact of fire on the site and are used with management factors in making slashburning decisions.

Category	Definition
Soil depth	depth from the mineral soil surface to a restricting layer such as bedrock, strongly compacted or strongly cemented materials (e.g. "hardpan").
Coarse fragments	unconsolidated materials > 2 mm diameter.
Humus form thickness	refers to thickness of organic horizons only (e.g. "forest floor").
Ae horizon	a leached horizon in the upper soil profile characterized by a greyish colour. A well-developed Ae is > 2 cm thick.
Ah horizon	an upper soil horizon enriched with organic matter (darker coloured than the underlying soil)
Soil particle size coarse	sandy[1] with > 35% coarse fragments or loamy[1] with > 70?% coarse fragments.
Silty texture	SiL or Si texture.
Gleying	soils have orange coloured mottles indicative of a fluctuating water table. Permanently gleyed soils are dull yellowish, blue, or olive in colour.
Mull	humus form comprised of very thin F and H horizons (<2 cm) overlying a well developed Ah horizon
Moder	humus form comprised of predominately F and H horizons (> 2 cm); the F horizon is loose and friable with common insects.
VH	very high sensitivity class.
H	high sensitivity class.
M	medium sensitivity class.
L	low sensitivity class.
VL	very low sensitivity class.

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[1] sandy - LS, S; loamy - SL, L, SCL

APPENDIX VII

Key to identification of site sensitivity to fire (part 2)

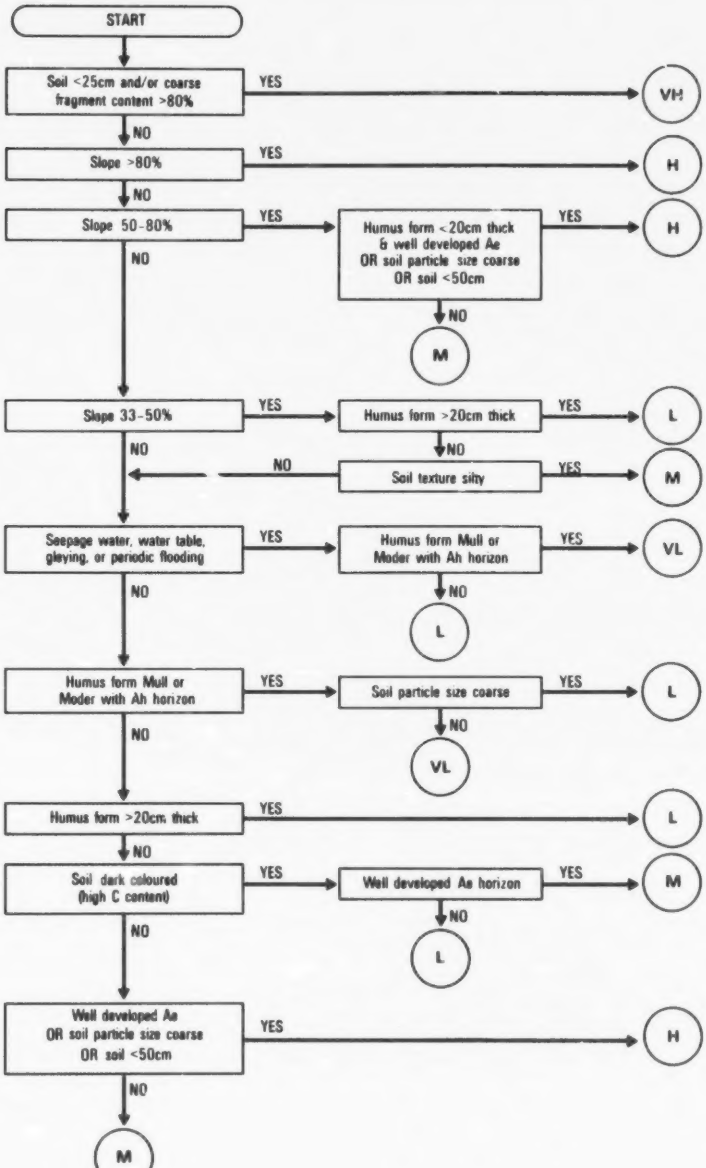
START
Soil <25cm and/or coarse fragment content >80%
YES
VH
NO
Slope >80%
YES
H
NO
Slope 50-80%
YES
Humus form <20cm thick & well developed Ae OR soil particle size coarse OR soil <50cm
YES
H
NO
M
NO
Slope 33-50%
YES
Humus form >20cm thick
YES
L
NO
Soil texture silty
YES
M
NO
NO
Seepage water, water table, gleying, or periodic flooding
YES
Humus form Mull or Moder with Ah horizon
YES
VL
NO
L
NO
Humus form Mull or Moder with Ah horizon
YES
Soil particle size coarse
YES
L
NO
VL
NO
Humus form >20cm thick
YES
L
NO
Soil dark coloured (high C content)
YES
Well developed Ae horizon
YES
M
NO
L
NO
Well developed Ae OR soil particle size coarse OR soil <50cm
YES
H
NO
M

FIGURE 34. Key to the identification of site sensitivity classes - Part 2.

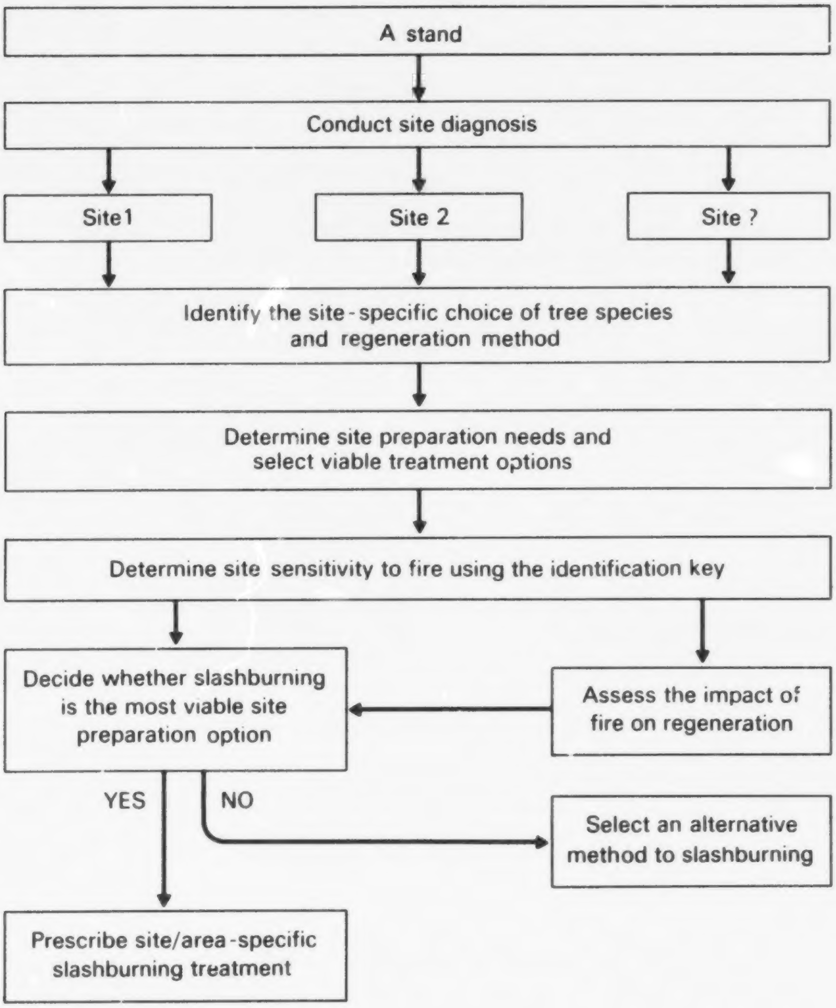
A stand
Conduct site diagnosis
Site 1
Site 2
Site ?
Identify the site-specific choice of tree species and regeneration method
Determine site preparation needs and select viable treatment options
Determine site sensitivity to fire using the identification key
Decide whether slashburning is the most viable site preparation option
Assess the impact of fire on regeneration
YES
NO
Select an alternative method to slashburning
Prescribe site/area-specific slashburning treatment

FIGURE 35. Flow chart illustrating the approach adopted to slashburning guidelines in the Vancouver Forest Region.

LITERATURE CITED

Aichinger, E. 1967. Pflanzen als forstliche Standortsanzeigers. Osterreichischer Agrarverlag, Wien. 366p.

Alexandrova, V.D. 1980. Russian approaches to classification. In Classification of plant communities. R.H. Whittaker (editor). Dr. W. Junk bv Publishers, The Hague., pp. 161-200.

Annas, R.M. and R. Coupe (eds.). 1979. Biogeoclimatic zones and subzones of the Cariboo Forest Region. Province of British Columbia, Ministry of Forests, Victoria. B.C. 103p.

Anonymous. 1941, 1946, 1960. Climate of British Columbia. Province of British Columbia, Victoria, B.C. Reports.

________. 1980. Summary of snow survey measurements in British Columbia, 1935-1980. Province of B.C., Ministry of Environment, Inventory and Engineering Branch. 219p.

Arbeitskreis Standortskartierung. 1978. Forstliche Standortsanfnahme. Arbeitskreis Standortskartierung in der Arbeitsgemeinschaft Forseinrichtung. Landwirtschaftsverlag GmbH, Munster-Hilrup. 183p.

Archer, A.C. 1963. Some synecological problems in the alpine zone of Garibaldi Park. M.Sc. thesis, Dep. of Biol. and Bot., University of British Columbia, Vancouver, B.C. 129p.

Armson, K.A. 1977. Forest soils: properties and processes. University of Toronto Press, Toronto. 390p.

Baker, J.B. 1977. Nutrient drain associated with hardwood plantation culture. 6p. in Proc. 2nd Symp. on Southeastern hardwood. South. Hardwood For. Res. Group, Dothan, Alabama.

Bakuzis, E.V. 1969. Forestry viewed in an ecosystem perspective. In The ecosystem concept in natural resource management. G.M. van Dyne (editor). Academic Press, New York., pp. 189-258.

Bakuzis, E.V. and V. Kurmis. 1978. Provisional list of synecological coordinates and selected ecographs of forest and other plant species in Minnesota. Department of Forest Resources. College of Forestry and the Agricultural Experiment Station, Staff Series Paper No. 5, University of Minnesota, St. Paul, Minnesota. 31p.

Ballard, R. 1980. The means to excellence through nutrient amendment. In Forest plantation: the shape of the future. Weyerhaeuser Science Symposium, V.I., Weyerhaeuser Company, Washington., pp. 159-200.

Barbour, G. and J. Major. (eds.). 1977. Terrestrial vegetation of California. John Wiley and Sons, New York. 1002 p.

Bell, M.A.M. 1971. Forest ecology. In Forestry handbook for British Columbia. Faculty of Forestry, University of British Columbia, Vancouver, B.C., pp. 200-287.

Brink, V.C. 1959. A directional change in the subalpine forest-heath ecotone in Garibaldi Park, B.C. Ecology 40:10-16.

British Columbia Department of Mines and Petroleum Resources. 1970. The identification of common rocks. 15p.

Brooke, R.C., E.B. Peterson, and V.J. Krajina. 1970. The subalpine Mountain Hemlock Zone. Ecol. Western N. Amer. 2:148-349.

Buckman, H.O. and N.C. Brady. 1969. The nature and properties of soils, 7th ed. The MacMillan Company, Toronto. 653p.

Buol, S.W., F.D. Hole, and R.J. McCraken. 1980. Soil genesis and classification. The Iowa State University Press, Ames, Iowa. 404p.

Cajander, A.K. 1949. Uber Waldtypen. Acta Forest. Fenn. 1:1-175.

Canadian Climate Program (CCP). 1981. Canadian climate normals, temperature and precipitation 1951-1980, British Columbia. Environment Canada, Atmospheric Environment Service. 268p.

Canada Soil Survey Committee (CSSC). 1978. The Canadian system of soil classification. Can. Dep. Agric. Publ. No. 1646. 164p.

Comeau, P.G., M.A. Comeau, and G.F. Utzig. 1982. A guide to plant indicators of moisture for southeastern British Columbia, with engineering interpretations. Province of British Columbia, Ministry of Forests, Land Management Handbook No. 5. 119p.

Cordes, L.D. 1972. An ecological study of the Sitka spruce forest on the West Coast of Vancouver Island. Ph.D. thesis, Dep. Bot., University of British Columbia, Vancouver, B.C. 452p.

Courtin, P.J., K. Klinka, J. Heineman, W.R. Mitchell and R.N. Green. 1981. Biogeoclimatic units, Victoria-Vancouver. Province of British Columbia. Ministry of Forests, Victoria, B.C. 1:500 000 coloured map.

Crum, H.A., W.C. Steere, and L.E. Anderson. 1973. A new list of mosses of North America north of Mexico. The Bryologist 76:85-130.

Dahl, E. 1956. Rondane Mountain vegetation in South Norway and its relation to the environment. Norske Vidensk-Akad. Oslo, Mat-Naturv. Kl., Skr. 1956(3):1-374.

Dansereau, P. 1957. Biogeography: an ecological perspective. The Ronald Press Co., New York. 394p.

Daubenmire, R.F. 1968. Plant communities. Harper & Row, Inc., New York. 300p.

______________. 1976. The use of vegetation in assessing the productivity of forest lands. Bot. Rev. 42:115-143.

DeBell, D.S. 1981. Increasing forest productivity through nutrient management. In Increasing forest productivity. Proceedings of the 1981 National Convention of the Society of American Foresters., pp. 51-55.

Douglas, G.W. and L.C. Bliss. 1977. Alpine and high subalpine plant communities of the North Cascades Range in Washington and British Columbia. Ecol. Monogr. 47:113-150.

Duchaufour, P. 1982. Pedology: pedogenesis and classification. George Allen & Unwin, London. 448p.

Eis, S. 1962. Statistical analysis of several methods for estimation of forest habitats and tree growth near Vancouver, B.C. Faculty of Forestry, University of British Columbia, For. Bull. No. 4, Vancouver, B.C. 76p.

Ellenberg, H. 1974. Zeigerwerte der Gefasspflanzen Mitteleuropas. Scripta Geobotanica 9:1-97.

______________. 1982. Vegetation Mitteleuropas mit der Alpen in okologischer Sicht. 3. Aufl., Verlag Eugen Ulmer, Stuttgart. 989p.

Etter, H. 1954. Grundsatzliche Betrachtungen zur Beschreibung und Kennreichnung der Biochore. Vegetatio 5(6):500-510.

Farrell, P.W., D.W. Flinn, R.D. Squire, and F.C. Craig. 1981. On the maintenance of productivity of radiata pine monocultures on sandy soils in south-east Australia. In 17th IUFRO World Congress Proc., Div. 1., pp. 117-128.

Feller, M.C. 1982. The ecological effects of slashburning with particular reference to British Columbia: a literature review. Province of British Columbia, Ministry of Forests, Land Management Report No. 13, Victoria, B.C. 60p.

Fowells, H.A. (ed.) 1965. Silvics of forest trees of the United States. USDA, Agriculture Handbook No. 271, Washington, D.C. 762p.

Frey, T.E.A. 1980. The Finnish School and forest site-types. In Classification of plant communities. R.H. Whittaker (editor). Dr. W. Junk bv Publishers, The Hague., pp. 81-110.

Genssler, H. 1982. The application of phytosociology in the forest management of the Federal Republic of Germany. In Application of vegetation science to forestry. G. Jahn (editor). Dr. W. Junk Publishers, The Hague., pp. 179-197.

Giles, D.G. 1983. Soil water regimes on a forested watershed. M.Sc. thesis, Dep. of Soil Science, University of British Columbia, Vancouver, B.C. 164p.

Glazovskaya, M.A. 1963. On geochemical principles of the classification of natural landscapes. Intern. Geological Rev. 5(11): 1403-1431.

Hale, M.E. and W.L. Culberson. 1970. A fourth checklist of the lichens of the continental United States and Canada. The Bryologist 73:499-543.

Hills, G.A. 1952. The classification and evaluation of site for forestry. Ontario Dept. Lands and For., Res. Rep. 24. 41p.

__________. 1955. Field methods for investigating site. Ontario Dept. Lands and For., Res. Manual 4. 119p.

__________. 1960. Regional site research. For. Chron. 36:401-423.

__________. 1961. The ecological basis for land use planning. Ontario Dept. Lands and For., Res. Rep. 46. 204p.

Inselberg, A.E., K. Klinka, and C. Ray. 1982. Ecosystems of MacMillan Park on Vancouver Island. Province of British Columbia, Ministry of Forests. Land Management Report 12, Victoria, B.C. 113p.

Jahn, G. 1982. (ed.). Application of vegetation science to forestry. Dr. W. Junk bv Publishers, The Hague, 405p.

Jenny, H. 1980. The soil resource. Ecological Studies 37, Springer Verlag, New York. 377p.

Jones, R.K., G. Pierpoint, G.M. Wickware, J.K. Jeglum, R.W. Arnup, and J.M. Bowles. 1983. Field guide to forest classification for the Clay Belt, Site Region 3E. Ministry of Natural Resources, Ontario. 123p.

Klinka, K. 1976. Ecosystem units, their classification, interpretation, and mapping in the University of British Columbia Research Forest. Ph.D. thesis, Faculty of Forestry, University of British Columbia, Vancouver, B.C. 622p.

__________. 1977. Guide for the tree species selection and prescribed burning in the Vancouver Forest District. Province of British Columbia, Ministry of Forests, Vancouver, B.C. 42p.

Klinka, K., F.C. Nuszdorfer, and L. Skoda. 1979. Biogeoclimatic units of central and southern Vancouver Island. Province of British Columbia, Ministry of Forests, Victoria, B.C. 120p.

Klinka, K., W.D. van der Horst, F.C. Nuszdorfer, and R.G. Harding. 1980. An ecosystem approach to a subunit plan: Koprino River watershed study. Province of British Columbia, Ministry of Forests, Land Management Report No. 5, Victoria, B.C. 118p.

Klinka, K., R.N. Green, R.L. Trowbridge, and L.E. Lowe. 1981a. Taxonomic classification of humus forms in ecosystems of British Columbia. Province of British Columbia, Ministry of Forests, Land Management Report No. 8, Victoria, B.C. 54p.

Klinka, K., M.C. Feller, and L.E. Lowe. 1981b. Characterization of the most productive ecosystems for growth of *Pseudotsuga menziesii* var. *mensiesii* in southwestern British Columbia. Province of British Columbia, Ministry of Forests, Victoria, B.C., Supplement to Land Management Report No. 6. 49p.

Klinka, K., M.C. Feller, and R.K. Scagel. 1982. Characterization of the most productive ecosystems for the growth of Engelmann spruce (*Picea engelmannii* Parry *ex* Engelm.) in southwestern British Columbia. Province of British Columbia, Ministry of Forests, Land Management Report No. 9., Victoria, B.C. 80p.

Klinka, K. and M.C. Feller. 1984. Principles used in selecting tree species for regeneration of forest sites in southwestern British Columbia. For. Chron. 60:77-85.

Kojima, S. and V.J. Krajina. 1975. Vegetation and environment of the Coastal Western Hemlock Zone in Stratchona Provincial Park, British Columbia, Canada. Syesis 8 (Suppl. 1):1-123.

Krajina, V.J. 1960. Ecosystem classification of forests. Silva Fennica 105:107-110.

_____________. 1969. Ecology of forest trees in British Columbia. Ecol. Western N. Amer. 2(1):1-146.

_____________. 1972. Ecosystem perspectives in forestry. The H.R. MacMillan lectureship in forestry. Faculty of Forestry, University of British Columbia, Vancouver, B.C. 31p.

_____________. 1973. Biogeoclimatic zones of British Columbia. Province of British Columbia, Dept. of Lands, Forests, and Water Resources, Ecological Reserves Committee. 1:1 900 800 coloured map.

Kreutzer, K. 1978. How do physical classifications contrast with site type classifications? pp. 39-56 in Forstl. Forsti. Anst. Munchen.

Lacate, D.S. (ed.). 1969. Guidelines for bio-physical land classification. Can. Dept. Fish. and Forest, Can. Forest Serv., Publ. 1264. 61p.

Landolt, E. 1977. Okologische Zeigerwerte zur Schweizer Flora. Veroffentlichungen des Geobotanischen Institutes der Eidg. Techn. Hochshule, 64 Heft, Zurich. 208p.

Lewis, T. 1976. The till-derived podzols of Vancouver Island. Ph.D. thesis, Soil Science Department, University of British Columbia, Vancouver, B.C. 158p.

Malcolm, P.C. 1981. Dynamics of forest ecosystems in relation to their utilization: North Temperate Zone. In Proceedings of the workshop on land evaluation for forestry. P. Laban (editor). Publ. 28. Int. Inst. for Land Reclamation and Improvement, Wagennigen, The Netherlands., pp. 48-62.

Mayer, H. 1977. Waldbau auf soziologish-okologischer Grundlage. Gustav Fisher Verlag, Stuttgart. 483p.

Major, J. 1951. A functional factorial approach to plant ecology. Ecology 32:392-412.

__________. 1963. A climatic index to vascular plant activity. Ecology 44:485-498.

McLean, A. 1970. Plant communities of the Similkameen Valley, British Columbia and their relationship to soils. Ecol. Monogr. 40(4):403-424.

McMinn, R.G. 1961. Water relations and forest distribution in the Douglas-fir region on Vancouver Island. Canada Dept. Agr., Publ. 1091. 71p.

Mezera, A. 1957. Flowering plants of our forests (in Czech). Statni Zemedelske Nakladatelstvi, Prague. 502p.

Minore, D. 1972. A classification of forest environments in the south Umpqua Basin. USDA Forest Service, Research Paper PNW-129, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. 28p.

Mitchell, W.R. and R.N. Green. 1981. Identification and interpretation of ecosystems of the western Kamloops Forest Region. Vol. 1 and 2. Province of British Columbia, Ministry of Forests, Land Management Handbook No. 2, Victoria, B.C.

Mueller-Dombois, D. 1964. The forest habitat types of southeastern Manitoba and their application to forest management. Can. J. Bot. 42:1417-1444.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, Toronto. 547p.

Nuszdorfer, F.C. and K. Klinka. 1982. Ecosystem-specific tree species selection. In Soil interpretations for forestry, Province of British Columbia, Ministry of Environment, APD Technical Paper 6, Ministry of Forests, Land Management Report No. 10, Victoria. B.C., pp. 137-150.

Orloci, L. 1961. Forest types of the Coastal Western Hemlock Zone. M.Sc. thesis, Dep. of Biol. and Bot., University of British Columbia, Vancouver, B.C. 206p.

__________. 1964. Vegetational and environmental variations in the ecosystems of the Coastal Western Hemlock Zone. Ph.D. thesis, Dep. Bot., University of British Columbia, Vancouver, B.C. 199p.

__________. 1965. The Coastal Western Hemlock Zone on the southwestern British Columbia mainland. Ecology of Western North America. 1:1837.

Pelisek, J. 1975. Conifer plantations and soil deterioration. Ecologist 5:322-336.

Perelman, A.I. 1966. Landscape geochemistry (Translation No. 676, Geological survey of Canada, 1972). Vysshaya Shkola, Moscow. 388p.

Pfister, R.D. and S.F. Arno. 1980. Classifying forest habitat types based on potential climax vegetation. Forest Sci. 26:52-70.

Pliva, K. and E. Prusa. 1969. Forest types as a framework for silviculture (in Czech). Statni Zemedelske Nakladatelstvi, Praha. 401p.

Pogrebnyak, P.S. 1930. Uber die Methodik der Standortsuntersuchungen in Verbindung mit den Waldtypen. *In* Proceedings of the International Congress of Forestry Experimental Stations, Stockholm, pp. 455-471.

Pojar, J., R. Love, D. Meidinger, and R. Scagel. 1982. Some common plants of the Sub-boreal Spruce Zone. Province of British Columbia, B.C. Ministry of Forests, Land Management Handbook No. 6, Victoria, B.C. 102p.

Polynov, B.B. 1951. Modern ideas of soil formation and development. Soils and Fertilizers 14(2):95-101.

Pritchett, W.L. 1979. Properties and management of forest soils. John Wiley & Sons, New York. 500p.

Ralston, C.W. 1964. Evaluation of forest site productivity. *In* Int. Rev. For. Res. 1. J.A. Romberger and P. Mikola (editors). Academic Press, New York., pp. 171-201.

Randuska, D. 1982. Forest typology in Czechoslovakia. *In* Application of vegetation science to forestry. G. Jahn (editor). Dr. W. Junk Publishers, The Hague., pp. 147-178.

Roehmer, H. 1972. Forest vegetation and environments on the Saanich Peninsula. Ph.D. thesis, Dep. of Biology, University of Victoria, Victoria, B.C. 405p.

Roy, R.J.J. 1984. Ordination and classification of immature forest ecosystems in the Cowichan Lake Area, Vancouver Island. M.Sc. thesis, Faculty of Forestry, University of British Columbia, Vancouver, B.C. 270p.

Russell, E.W. 1973. Soil conditions and plant growth. Longman, London. 849 p.

Rysin, L.P. 1982. Forest typology in USSR (in Russian) Izd. Nauka, Moscow. 217p.

Shonhar, S. 1952. Untersuchungen uber die Korrelation zwischen der floristichen Zusammensetzung der Bodenvegetation und der Bodenaciditat sowie anderen chemischen Bodenfaktoren. Mitt. Forst. Standortskartierung 2:1-23.

Silen, R.R. 1982. Nitrogen, corn, and forest genetics. USDA, Forest Service, Pacific Northwest Forest and Range Experimental Station, General Technical Report PNW-137. Portland, Oregon. 20p.

Soil Survey Staff. 1951. Soil survey manual. USDA Agriculture Handbook 18, Washington, D.C. 503p.

_______________. 1975. Soil taxonomy. USDA, Soil Conservation Service, Handbook No. 436, Washington, D.C. 754p.

Sondheim, M.W. and Klinka, K. 1983. The relationship of soil and physiographic attributes to an ecological classification system. Can. J. Soil Sci. 63:97-112.

Spurr, J.E. and Barnes, B.V. 1980. Forest ecology. John Wiley, New York. 687p.

Squire, R.O. and D.W. Flinn. 1981. Site disturbance and nutrient economy of plantations with special reference to radiata pine on sands. In Proceedings Australian Forest Nutrition Workshop: Productivity in perpetuity. CSIRO Division of Forest Research, Canberra., pp. 291-302.

Sukachev, V.N., and N. Dylis. 1968. Fundamentals of forest biogeocoenology. Oliver & Boyd Ltd., Edinburgh and London. 672p.

Svoboda, P. 1949. Prinos sovetske vedy k lesni typologii. Lesnicka Prace 28(11-12):453-535.

Taylor, R.L. and B. MacBryde. 1977. Vascular plants of British Columbia. Tech. Bull. No. 4. Univ. of British Columbia Press, Vancouver, B.C. 754p.

Tisdale, S.L. and W.L. Nelson. 1975. Soil fertility and fertilizers. The MacMillan Company, New York. 693p.

Thornthwaite, C.W. 1948. An approach toward a rational classification of climate. Geogr. Rev. 39:55-94.

Thornthwaite, C.W. and J.R. Mather. 1955. The water balance. Drexel Inst. of Technol., Publ. in Climatology 8(1):1-104.

Thornthwaite, C.W., J.R. Mather, and D.B. Carter. 1957. Instructions and tables for computing potential evapotranspiration and the water balance. Drexel Inst. of Technol., Publ. in Climatology 10(3):183-311.

Tsiganov, D.N. 1983. Phyto-indication of ecological regimes in the coniferous-broadleaf subzone. (in Russian). Izd. Nauka, Moscow. 197p.

Viktorov, S.V., E.A. Vostokova, and D.D. Vyshiukin. 1965. Some problems in the theory of geobotanical indicator research. In Plant indicators of soils, rocks, and subsurface waters. A.G. Chukisher (editor). Consultants Bureau, New York., pp. 1-4.

Wali, M.K. and V.J. Krajina. 1973. Vegetation-environment relationships of some Sub-Boreal Spruce Zone ecosystems in British Columbia. Vegetetio 26:237-381.

Walmsley, M., G. Utzig, T. Vold, D. Moon, and J. van Barneveld. 1980. Describing ecosystems in the field. Province of British Columbia, Ministry of Environment, R.A.B. Tech. Paper 2, Ministry of Forests, Land Management Report No. 7, Victoria, B.C. 225p.

Walter, H. 1973. Vegetation of the earth in relation to climate and the eco-physiological conditions. (Translated from German by J. Wieser). The English Universities Press, London and Springer-Verlag, New York. 237 p.

Westhoff, V. and E. van der Maarel. 1980. The Braun-Blanquet approach. In Classification of plant communities. R.H. Whittaker (editor). Dr. W. Junk bv Publishers, The Hague., pp. 287-399.

Whittaker, R.H. (ed.). 1978. Classification of plant communities. Dr. W. Junk bv Publishers, The Hague. 408p.

Wilde, S.A. 1958. Forest soils. Ronald Press Co., New York. 537p.

Appendix. Alphabetical list of edatopic indicator plant species.

Latin name	Common name	Life-form[1]	EISG No.
*[2]Acer circinatum	vine maple	dcsh	3.5
* Acer glabrum	Douglas maple	dcsh	3.4
* Acer macrophyllum	bigleaf maple	brtr	3.5
Achillea lanulosa	western yarrow	herb	3.2
* Achlys triphylla	vanilla leaf	herb	3.4
* Actaea rubra	baneberry	herb	3.6
* Adenocaulon bicolor	pathfinder	herb	3.3
* Adiantum pedatum	maidenhair fern	fern	3.6
* Agropyron spicatum	bluebunch wheatgrass	gram	3.1
Aira caryophyllea	silver hairgrass	gram	2.1
Aira praecox	early hairgrass	gram	2.1
Allium acuminatum	Hooker's onion	herb	3.2
Allium cernuum	nodding onion	herb	3.2
* Allotropa virgata	candystick	pasa	1.2
* Alnus rubra	red alder	brtr	3.6
* Amelanchier alnifolia	Saskatoon	dcsh	2.2
Andromeda polifolia	bog rosemary	herb	1.7
Angelica genuflexa	kneeling angelica	herb	3.7
* Apocynum androsaemifolium	spreading dogbane	herb	2.1
* Aquilegia formosa	red columbine	herb	3.5
* Aralia nudicaulis	wild sarsaparilla	herb	3.4
* Arbutus menziesii	arbutus	brtr	1.2
* Arctostaphylos columbiana	hairy manzanita	evsh	2.1
* Arctostaphylos uva-ursi	kinnikinnick	evsh	2.1
* Arnica cordifolia	heart-leaved arnica	herb	2.2
* Arnica latifolia	mountain arnica	herb	2.4
* Aruncus dioicus	goat's-beard	herb	3.5
* Asarum caudatum	wild ginger	herb	3.5
* Asplenium trichomanes	maidenhair spleenwort	fern	2.2
Aster ciliolatus	fringed aster	herb	3.3
* Aster conspicuus	showy aster	herb	3.3
* Athyrium filix-femina	lady fern	fern	3.6
Atrichum selwynii		moss	3.5
Barbilophozia floerkei		lvrt	1.3
Barbilophozia lycopodioides	common leafy liverwort	lvrt	1.3
Bartramia pomiformis	apple moss	moss	2.2
Bazzania tricrenata		lvrt	1.6
* Blechnum spicant	deer fern	fern	1.6
* Boschniakia hookeri	groundcone	pasa	1.2
Boykinia elata	coast boykinia	herb	3.6
Brachythecium albicans	lawn moss	moss	1.3

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[1] Legend to life-form codes on page 180.

[2] Species marked with asterisks are a desirable standard for operational use

Appendix. (continued)

Latin name	Common name	Life-form	EISG No.
Bromus carinatus	California brome	gram	3.2
Bromus vulgaris	Columbia brome	gram	3.5
Calamagrostis canadensis	bluejoint	gram	3.6
Calamagrostis nutkaensis	Pacific reedgrass	gram	3.5
* Calamagrostis rubescens	pinegrass	gram	3.3
* Caltha biflora	two-flowered white marsh-marigold	herb	3.7
* Caltha leptosepala	alpine white marsh-marigold	herb	3.7
Calypogeja trichomanis		lvrt	1.5
* Calypso bulbosa	fairy-slipper	herb	2.3
Camassia leichtlinii	great camas	herb	3.2
* Camassia quamash	common camas	herb	3.2
Campanula scouleri	Scouler's harebell	herb	3.1
Cardamine breweri	Brewer's bitter-cress	herb	3.7
Cardamine nuttallii	Nuttall's bitter-cress	herb	3.6
Carex aquatilis	water sedge	gram	3.7
Carex deweyana	Dewey's sedge	gram	3.6
Carex hendersonii	Henderson's sedge	gram	3.6
Carex laeviculmis	smooth-stemmed sedge	gram	3.7
Carex livida	pale sedge	gram	3.7
Carex obnupta	slough sedge	gram	3.7
Carex pensylvanica	long-stoloned sedge	gram	3.1
Carex rossii	Ross' sedge	gram	3.2
* Cassiope mertensiana	white mountain-heather	evsh	1.4
* Cassiope stelleriana	Alaskan mountain-heather	evsh	1.5
* Cassiope tetragona	four-angled moutain-heather	evsh	2.4
* Ceanothus sanguineus	redstem ceanothus	dcsh	3.2
Ceanothus velutinus	snowbush ceanothus	evsh	3.2
* Chimaphila menziesii	Menzies' pipsissewa	evsh	1.4
* Chimaphila umbellata	prince's pine	evsh	1.2
Cinna latifolia	nodding wood-reed	gram	3.6
* Circaea alpina	alpine enchanter's - nightshade	herb	2.4
Circaea pacifica	Pacific enchanter's-nightshade	herb	3.5
Cladina[3] arbuscula		lchn	1.1
Cladina[3] impexa		lchn	1.1
Cladina[3] mitis		lchn	1.1
Cladina[3] rangiferina		lchn	1.1
Cladina[3] stellaris		lchn	1.1
Cladonia bellidiflora	red top lichen	lchn	1.2
Cladonia[3] gracilis		lchn	1.1
Cladothamnus pyroliflorus	copperbush	dcsh	1.5

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[3] May all be referred to as lichen spp.

Appendix. (continued)

Latin name	Common name	Life-form	EISG No.
* Claytonia sibirica	Siberian miner's-lettuce	herb	3.5
* Clintonia uniflora	queen's cup	herb	1.4
Collinsia parviflora	small-flowered blue-eyed Mary	herb	3.4
* Conocephalum conicum		lvrt	3.6
* Coptis aspleniifolia	fern-leaved goldthread	herb	1.6
* Coptis trifolia	three-leaved goldthread	herb	1.6
* Corallorhiza mertensiana	western coralroot	pasa	1.4
* Cornus canadensis	bunchberry	herb	1.4
* Cornus nuttallii	flowering dogwood	brtr	3.3
* Cornus sericea	red-osier dogwood	dcsh	3.6
* Cornus unalaschkensis	Cordilleran bunchberry	herb	1.5
Corylus cornuta	hazelnut	dcsh	3.3
Crataegus douglasii	black hawthorn	dcsh	3.6
Cryptogramma crispa	parsley fern	fern	2.1
Cystopteris fragilis	fragile fern	fern	3.4
* Cytisus scoparius	broom	dcsh	1.2
Danthonia californica	California oatgrass	gram	2.1
Danthonia spicata	poverty oatgrass	gram	2.1
* Dicentra formosa	bleeding heart	herb	3.5
Dicranum fuscescens		moss	1.2
Dicranum howellii		moss	1.3
Dicranum pallidisetum		moss	1.3
Dicranum tauricum	broken-leaf moss	moss	1.2
Diplophyllum albicans		lvrt	3.6
* Disporum hookeri	Hooker's fairybells	herb	3.4
Disporum smithii	Smith's fairybells	herb	3.5
Disporum trachycarpum	rough-fruited fairybells	herb	3.4
Dodecatheon hendersonii	broad-leaved shootingstar	herb	3.4
Dodecatheon pulchellum	few-flowered shootingstar	herb	3.4
* Drosera rotundifolia	round-leaved sundew	herb	1.7
* Dryopteris expansa	spiny wood fern	fern	1.5
Elymus glaucus	blue wildrye	gram	3.3
* Empetrum nigrum	crowberry	evsh	1.4
Equisetum hyemale	scouring-rush	fern	3.5
* Equisetum pratense	meadow horsetail	fern	3.6
Equisetum sylvaticum	wood horsetail	fern	3.7
* Equisetum telmateia	giant horsetail	fern	3.7
Erigeron peregrinus	subalpine daisy	herb	3.6
Eriophorum angustifolium	narrow-leaved cotton-grass	gram	1.7
Eriophyllum lanatum	woolly sunflower	herb	3.1
Erythronium oregonum	white fawn lily	herb	3.2
Erythronium revolutum	pink fawn lily	herb	3.5

Appendix. (continued)

Latin name	Common name	Life-form	EISG No.
Fauria crista-galli	deer cabbage	herb	1.7
* Festuca occidentalis	western fescue	gram	1.3
Festuca subulata	bearded fescue	gram	3.5
Festuca subuliflora	crinkle-awned fescue	gram	3.5
Fontinalis antipyretica		moss	1.7
Fritillaria lanceolata	chocolate lily	herb	3.4
Galium aparine	cleavers	herb	3.4
* Galium triflorum	sweet-scented bedstraw	herb	3.5
Gaultheria hispidula	creeping-snowberry	evsh	1.5
Gaultheria humifusa	alpine-wintergreen	evsh	1.5
* Gaultheria ovatifolia	western tea-berry	evsh	1.2
* Gaultheria shallon	salal	evsh	1.4
Gentiana douglasiana	swamp gentian	herb	1.7
Gentiana sceptrum	king gentian	herb	1.7
Geocaulon lividum	bastard toad-flax	herb	1.5
* Geum macrophyllum	large-leaved avens	herb	3.5
* Goodyera oblongifolia	rattlesnake-plantain	herb	1.3
* Gymnocarpium dryopteris	oak fern	fern	3.5
Hemitomes congestum	gnome-plant	pasa	2.4
Heracleum lanatum	crow-parsnip	herb	3.5
* Hieracium albiflorum	white-flowered hawkweed	herb	1.3
Holcus lanatus	Yorkshire fog	gram	2.3
* Holodiscus discolor	ocean-spray	dcsh	2.1
* Homalothecium megaptilum		moss	1.2
Hookeria lucens		moss	3.6
* Hylocomium splendens	step moss	moss	1.4
Hypericum formosum	western St. John's-wort	herb	2.3
Hypochoeris radicata	hairy cat's-ear	herb	1.3
Hypopitys lanuginosa	pinesap	pasa	1.3
Isopterygium elegans		moss	1.5
Juncus effusus	common rush	gram	3.7
Juncus ensifolius	dagger-leaved rush	gram	3.7
* Juniperus scopulorum	Rocky Mountain juniper	evsh	3.1
Juniperus sibirica	common juniper	evsh	3.2
* Kalmia microphylla	bog-laurel	evsh	1.7
* Kindbergia oregana		moss	2.2
* Kindbergia praelonga		moss	3.6
Lathyrus nevadensis	purple peavine	herb	3.3
Lathyrus ochroleucus	creamy peavine	herb	3.4
* Ledum groenlandicum	Labrador tea	evsh	1.7

Appendix. (continued)

Latin name	Common name	Life-form	EISG No.
Lepidozia reptans		lvrt	1.5
* Leucolepis menziesii		moss	3.6
* Lilium columbianum	tiger lily	herb	2.2
* Linnaea borealis	twinflower	evsh	1.4
* Listera banksiana	northwestern twayblade	herb	2.4
Listera convallarioides	broad-leaved twayblade	herb	3.7
* Listera cordata	heart-leaved twayblade	herb	1.4
* Lonicera ciliosa	orange honeysuckle	dcsh	3.2
* Lonicera hispidula	purple honeysuckle	dcsh	3.2
* Lonicera involucrata	black twinberry	dcsh	3.5
* Lonicera utahensis	red twinberry	dcsh	2.3
* Luetkea pectinata	partridge foot	herb	2.4
* Lupinus arcticus	arctic lupine	herb	3.3
Lupinus nootkatensis	Nootka lupine	herb	3.4
Luzula multiflora	many-flowered woodrush	gram	2.1
* Luzula parviflora	small-flowered woodrush	gram	2.4
* Lycopodium annotinum	stiff club-moss	fern	1.3
* Lycopodium clavatum	running club-moss	fern	1.3
Lycopodium complanatum	ground-cedar	fern	1.3
* Lysichitum americanum	skunk cabbage	herb	3.7
Madia madioides	woodland tarweed	herb	3.2
* Mahonia aquifolium	tall Oregon-grape	evsh	3.2
* Mahonia nervosa	dull Oregon-grape	evsh	2.2
* Maianthemum dilatatum	false lily-of-the-valley	herb	3.6
* Malus fusca	Pacific crab apple	brtr	3.7
Marchantia polymorpha		lvrt	3.6
Melica subulata	Alaska onion grass	gram	3.4
* Menziesia ferruginea	false azalea	dcsh	1.5
* Mitella breweri	Brewer's mitrewort	herb	3.6
Mitella nuda		herb	3.6
* Mitella ovalis	oval-leaved mitrewort	herb	3.6
* Mitella pentandra	five-stamened mitrewort	herb	3.6
Mnium spinulosum		moss	2.3
Moehringia macrophylla	big-leaved sandwort	herb	3.3
* Moneses uniflora	single delight	herb	2.4
* Monotropa uniflora	Indian-pipe	pasa	2.4
* Montia parvifolia	small-leaved montia	herb	2.3
* Mycelis muralis	milkweed	herb	3.5
* Myrica gale	sweet gale	dcsh	3.7
* Oemleria cerasiformis	Indian-plum	dcsh	3.5
* Oenanthe sarmentosa	Pacific oenanthe	herb	3.7
* Oplopanax horridus	devil's club	dcsh	3.6
* Orthilia secunda	one-sided wintergreen	herb	1.3
* Osmorhiza chilensis	mountain sweet-cicely	herb	3.5

Appendix. (continued)

Latin name	Common name	Life-form	EISG No.
Parnassia fimbriata	fringed grass-of-Parnassus	herb	3.6
* Paxistima myrsinites	falsebox	evsh	1.3
* Pedicularis bracteosa	bracted lousewort	herb	2.4
* Pedicularis racemosa	sickletop lousewort	herb	2.2
Pellia neesiana		lvrt	3.7
* Peltigera aphthosa		lchn	1.2
* Peltigera membranacea		lchn	1.3
Perideridia gairdneri	yampah	herb	3.3
Petasites frigidus	sweet colt's-foot	herb	3.6
Petasites palmatus	palmate colt's-foot	herb	3.6
* Philadelphus lewisii	mock-orange	dcsh	3.4
Philonotis fontana		moss	3.7
* Phyllodoce empetriformis	pink mountain-heather	evsh	1.4
* Phyllodoce glanduliflora	yellow mountain-heather	evsh	3.3
* Physocarpus capitatus	Pacific ninebark	dcsh	3.6
Plagiochila porelloides		lvrt	2.4
* Plagiomnium insigne		moss	3.6
* Plagiothecium undulatum		moss	1.5
* Platanthera dilatata	white bog-orchid	herb	3.7
* Platanthera orbiculata	round-leaved rein-orchid	herb	1.3
* Pleurozium schreberi	red-stemmed feather moss	moss	1.3
* Pogonatum contortum		moss	2.4
Pogonatum sylvaticum		moss	2.4
* Polypodium glycyrrhiza	licorice fern	fern	3.3
Polypodium scouleri	leatherleaf polypody	fern	3.5
Polystichum braunii	Braun's holly-fern	fern	3.5
* Polystichum lonchitis	mountain holly-fern	fern	3.3
* Polystichum munitum	sword fern	fern	3.4
* Polytrichum juniperinum		moss	1.3
Polytrichum piliferum		moss	2.1
* Populus tremuloides	trembling aspen	brtr	3.3
* Populus trichocarpa	black cottonwood	brtr	3.5
Potentilla glandulosa	sticky cinquefoil	herb	3.4
Prenanthes alata	western rattlesnake root	herb	3.5
* Prunus virginiana	choke cherry	dcsh	3.4
* Pteridium aquilinum	bracken	fern	3.3
* Pterospora andromedea	pinedrops	pasa	2.1
* Ptilium crista-castrensis	knight's plume moss	moss	1.4
* Pyrola asarifolia	pink wintergreen	herb	2.3
* Pyrola chlorantha	green wintergreen	herb	2.3
Pyrola dentata	Nootka wintergreen	herb	2.1
* Pyrola picta	white-veined wintergreen	herb	2.3
* Quercus garryana	Garry oak	brtr	3.2

Appendix. (continued)

Latin name	Common name	Life-form	EISG No.
Ranunculus eschscholzii	subalpine buttercup	herb	3.6
* Ranunculus occidentalis	western buttercup	herb	3.4
Ranunculus repens	creeping buttercup	herb	3.7
Ranunculus uncinatus	little buttercup	herb	3.6
* Rhacomitrium canescens		moss	1.1
Rhacomitrium heterostichum		moss	1.1
* Rhamnus purshianus	cascara	dcsh	3.6
* Rhizomnium glabrescens		moss	2.4
Rhizomnium magnifolium		moss	3.7
Rhizomnium nudum		moss	3.6
* Rhododendron albiflorum	white-flowered rhododendron	dcsh	1.4
Rhynchospora alba	beak-rush	gram	1.7
* Rhytidiadelphus loreus		moss	1.5
Rhytidiadelphus squarrosus		moss	3.6
* Rhytidiadelphus triquetrus	electrified cat's tail moss	moss	3.3
* Rhytidiopsis robusta	pipecleaner moss	moss	1.4
* Ribes bracteosum	stink currant	dcsh	3.6
Ribes divaricatum	wild gooseberry	dcsh	3.4
* Ribes lacustre	black gooseberry	dcsh	3.5
* Ribes lobbii	gummy gooseberry	dcsh	3.2
* Ribes sanguineum	red-flowering currant	dcsh	3.3
* Rosa acicularis	prickly rose	dcsh	3.4
* Rosa gymnocarpa	baldhip rose	dcsh	1.3
* Rubus idaeus	red raspberry	dcsh	3.4
* Rubus leucodermis	black raspberry	dcsh	3.4
* Rubus parviflorus	thimbleberry	dcsh	3.4
* Rubus pedatus	five-leaved bramble	evsh	1.5
Rubus pubescens	trailing raspberry	evsh	3.5
* Rubus spectabilis	salmonberry	dcsh	3.6
* Rubus ursinus	trailing blackberry	dcsh	2.2
Salix hookeriana	Hooker's willow	dcsh	3.6
Salix scouleriana	Scouler's willow	dcsh	2.3
* Sambucus racemosa	elderberry	dcsh	3.4
* Sanguisorba canadensis	Sitka burnet	herb	1.6
* Sanguisorba officinalis	great burnet	herb	1.6
Sanicula crassicaulis	western snake-root	herb	3.3
Sanicula graveolens	Sierra sanicle	herb	3.2
Satureja douglasii	yerba buena	evsh	3.2
* Scirpus microcarpus	small-flowered bulrush	gram	3.7
* Sedum spathulifolium	broad-leaved stonecrop	herb	3.1
* Selaginella wallacei	Wallace's selaginella	fern	3.1
Senecio sylvaticus	wood groundsel	herb	3.4
Senecio vulgaris	common groundsel	herb	3.4
* Shepherdia canadensis	soopolallie	dcsh	3.3
Siphula ceratites		lchn	1.6

Appendix. (continued)

	Latin name	Common name	Life-form	EISG No.
	Sisyrinchium douglasii	satin-flower	herb	3.3
*	Smilacina racemosa	false Solomon's-seal	herb	3.4
*	Smilacina stellata	star-flowered false Solomon's-seal	herb	3.4
*	Sorbus scopulina	western mountain-ash	dcsh	1.3
*	Sorbus sitchensis	Sitka mountain-ash	dcsh	1.3
	Sphagnum[4] fallax		moss	1.7
	Sphagnum[4] fuscum		moss	1.7
	Sphagnum[4] girgensohnii		moss	1.7
	Sphagnum palustre		moss	3.7
	Sphagnum[4] papillosum		moss	1.7
	Sphagnum[4] tenellum		moss	1.7
*	Spiraea betulifolia	birch-leaved spirea	dcsh	3.3
	Spiraea densiflora	subalpine spirea	dcsh	2.3
*	Spiraea douglasii	hardhack	dcsh	1.6
	Spiraea menziesii	pink spirea	dcsh	3.6
*	Stachys cooleyae	Cooley's hedge-nettle	herb	3.6
	Stachys mexicana	Mexican hedge-nettle	herb	3.6
	Stellaria crispa	crisp starwort	herb	3.6
	Stenanthium occidentale	mountainbells	herb	1.6
	Stereocaulon tomentosum		lchn	1.1
*	Streptopus amplexifolius	clasping twistedstalk	herb	3.5
*	Streptopus roseus	rosy twistedstalk	herb	3.5
*	Streptopus streptopoides	small twistedstalk	herb	1.5
*	Symphoricarpos albus	common snowberry	dcsh	3.4
*	Symphoricarpos hesperius	trailing snowberry	dcsh	3.2
*	Taxus brevifolia	western yew	cntr	3.4
*	Tellima grandiflora	tall fringecup	herb	3.5
*	Thalictrum occidentale	western meadowrue	herb	3.5
*	Tiarella laciniata	cut-leaved foamflower	herb	3.5
*	Tiarella trifoliata	three-leaved foamflower	herb	3.5
*	Tiarella unifoliata	one-leaved foamflower	herb	2.3
	Timmia austriaca		moss	3.3
	Tofieldia glutinosa	sticky false asphodel	herb	3.7
*	Tolmiea menziesii	piggy-back plant	herb	3.5
	Torreyochloa pauciflora	false manna	gram	3.7
*	Trautvetteria caroliniensis	false bugbane	herb	3.6
	Trichophorum caespitosum	tufted deer-grass	gram	1.7
	Trientalis arctica	northern starflower	herb	1.7
*	Trientalis latifolia	broad-leaved starflower	herb	3.3
*	Trillium ovatum	trillium	herb	3.5
	Trisetum cernuum	nodding trisetum	gram	3.5

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[4] May all be referred to as Sphagnum spp.

Appendix. (continued)

Latin name	Common name	Life-form	EISG No.
Urtica dioica	stinging nettle	herb	3.5
* Vaccinium alaskaense	Alaskan blueberry	dcsh	1.5
* Vaccinium caespitosum	dwarf blueberry	dcsh	1.5
* Vaccinium deliciosum	Cascade blueberry	dcsh	1.5
* Vaccinium membranaceum	black huckleberry	dcsh	1.3
* Vaccinium ovalifolium	oval-leaved blueberry	dcsh	2.3
* Vaccinium ovatum	evergreen huckleberry	evsh	1.3
* Vaccinium oxycoccos	bog cranberry	evsh	1.7
* Vaccinium parvifolium	red huckleberry	dcsh	1.3
* Vaccinium scoparium	grouseberry	dcsh	2.1
* Vaccinium uliginosum	bog blueberry	dcsh	1.6
Vahlodea atropurpurea	mountain hairgrass	gram	1.6
Valeriana scouleri	Scouler's Sitka valerian	herb	3.6
* Valeriana sitchensis	Sitka valerian	herb	3.6
* Veratrum viride	Indian hellabore	herb	3.6
* Veronica americana	American brooklime	herb	3.7
* Viburnum edule	highbush-cranberry	dcsh	3.6
Viburnum trilobum	American bush-cranberry	dcsh	3.6
Vicia americana	American vetch	herb	2.3
* Viola adunca	early blue violet	herb	2.2
* Viola glabella	stream violet	herb	3.6
* Viola orbiculata	round-leaved violet	herb	1.3
* Viola sempervirens	trailing yellow violet	herb	2.2
Zygadenus venenosus	death-camas	herb	3.2

Codes to life-form

cntr - coniferous trees
brtr - broad-leaved trees
dcsh - deciduous shrubs
evsh - evergreen shrubs
fern - ferns and fern-allies
gram - graminoids, grasses, sedges, and rushes
herb - herbs
lchn - lichens
lvrt - liverworts
moss - mosses
pasa - parasites and saprophytes